FLIGHT
and The AIRCRAFT ENGINEER

First Aeronautical Weekly in the World : Founded 1909

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Editorial, Advertising and Publishing Offices: DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1
Telegrams: Truditur, Sedist, London. Telephone: Waterloo 3333 (50 lines).

8-10, CORPORATION ST., COVENTRY. *Telegrams:* Autocar, Coventry. *Telephone:* Coventry 5210.
GUILDHALL BUILDINGS, NAVIGATION ST., BIRMINGHAM, 2. *Telegrams:* Autopress, Birmingham. *Telephone:* Midland 2971 (5 lines).
260, DEANSGATE, MANCHESTER, 3. *Telegrams:* Iliffe, Manchester. *Telephone:* Blackfriars 4412
26B, RENFIELD ST., GLASGOW, C.2. *Telegrams:* Iliffe, Glasgow. *Telephone:* Central 4857.

SUBSCRIPTION RATES: Home and Canada: Year, £1 13 0. 6 months, 16s. 6d. 3 months, 8s. 3d.
Other Countries: Year, £1 16 0. 6 months, 18s. 0d. 3 months, 9s. 0d.

No. 1629. Vol. XXXVII. MARCH 14, 1940. Thursdays, Price 6d.

The Outlook

Poor Outlook for Civil Aviation

THOSE optimists who had expected the Air Minister to announce substantial help for civil aviation will have received something of a shock. What Sir Kingsley Wood said in introducing the Air Estimates gives no hope for British civil aviation while the war lasts. What does it amount to? An advisory committee to "keep under review the position of civil aviation in the light of the present situation and to plan for the future." And a small body of experts "whose task it will be to keep in close touch with all phases of technical development in the field of civil aviation abroad."

In short, a committee and a sort of technical sub-committee, whose only function will be to *watch*. The Air Minister's statement that "thus the aircraft industry of this country will be enabled to keep abreast of technical improvements on the civil side and be ready when peace returns" is unworthy of the man who had so much to do with the planning and carrying through of the "all-mails-by-air" scheme, first as Postmaster-General and afterwards as Secretary of State for Air. Mere watching of what others are doing will not get us very far on the road to post-war commercial aviation. Action is what is needed.

Sir Kingsley Wood took a certain amount of pride in what Great Britain has achieved in the past, as well he might. But our balance sheet cannot be made up with items which stood on the credit side of the ledger in pre-war days. He said that Imperials had carried on the Empire services since the war without interruption. That is true, but only partly so. The services have been curtailed; the aircraft that have had to be taken into use are largely unsuitable—not on account of any actual defects in the machines, but because the types were in many cases designed for a different class of service and a different kind of route.

On the Airways Corporation Sir Kingsley was no more encouraging. His announcement that Mr. Clive Pearson has been made chairman gives no cause for complacency. Mr. Pearson is a director of the Southern Railway, and it is quite bad enough to have internal aviation bossed by the railways. If the Empire routes are also to be under the "dead man's hand" of the railways, the outlook is poor indeed.

The Swelling R.A.F.

NO belligerent country could have wished for a more heartening speech from a defence Minister than the account of R.A.F. progress which Sir Kingsley Wood gave the House of Commons last Thursday. Possibly the most satisfactory item, because it was most unexpected by the majority of people, was his estimate that Britain and France have now surpassed Germany in output of aircraft. One of our bogies just before the war was the immense output of the German factories as compared with those of France and Britain. Of course, the present estimate includes purchases from the United States, which is in itself a testimony to the financial strength of the Allies and also to their command of the seas. When we remember that the factories in Canada are now also getting into production, the prospect, so far as mere numbers go, is distinctly cheering.

The House of Commons was naturally pleased, yet every now and again comparisons are made between present output and the output of the last war. Honourable members do not always bear in mind the difference between producing wooden aircraft and metal ones. They need constant reminders on that point. A Wellington takes up many more man-hours than were required for a Handley Page O/400.

As regards the quality of our machines, the House of Commons and the public have already been able to realise our superiority. Sir Kingsley's remark that he

would sooner have 100 Wellingtons or 100 Spitfires or Hurricanes than a larger number of comparable German machines, recalls a dictum of Lord Trenchard that a good squadron can cut its way through a superior number of inferior quality "as a knife cuts through butter." It was, of course, to be expected that we should produce improved types as time went on, and the Air Minister's estimate of some of the improvements which are in hand cannot make comforting reading for the *Luftwaffe*. We naturally expect the enemy likewise to produce new types, but it is difficult to recover from a bad start in time of war. The Germans must be bitterly regretting their neglect of the power-operated turret; but with no experience in its production behind them, they will not readily catch up our lead.

Air Strategy and Tactics

IT is strange to find Members of Parliament who even at this time seem to think that air defence can build an impenetrable wall along the coasts of Britain and protect every fishing boat from air attacks. Sir Kingsley Wood had to correct these false ideas. During the winter the cloudy skies have helped the raiders, and if the skies grow clear with the approach of spring the chances of a raider escaping from our fighters will become much more slender. We must be thankful that during the winter months the Germans have been so economical in the number of aircraft they have sent to worry us. We have remarked before now that the attack on our command of the seas (brutally though it has been carried out) showed good strategic sense, for only by trying to damage our dominance on the seas could the *Luftwaffe* do anything considerable towards helping the German cause. The small scale of the attacks has shown that the tactical execution of the plan was not on a par with its strategical conception. It seems to indicate the constant need for economy of petrol and of trained airmen, which is one of Germany's main preoccupations.

This limiting of the air campaign to bare essentials has enabled the Allies to make good the deficiencies in numbers of aircraft with which they started the war, and also to train their air crews to a pitch which the Germans have not attempted to rival. At present one of our minor embarrassments is to dispose of the great numbers of young men who are clamouring to join the Air Force. We have plenty of pilots and observers who know their way all over Germany and beyond. Against that the enemy has a limited number of men who can find their way to the coasts of Britain, but very few indeed who have any knowledge of what lies inland. Our training facilities will be increased when flying schools are opened by us in France. This is a new move, and it is an excellent one. As for fighting spirit, all our men, in fighters, in bombers, in coastal reconnaissance machines, are always ready for a fight, and they attack the enemy with confidence. They have confidence in themselves and in their machines, and that spirit is half the victory.

"TAILS WELL UP" might be the title of this picture of fighter pilots rushing to their machines on receipt of a raid warning from Headquarters. It forms an appropriate frontispiece for an issue specially devoted to Military Aircraft.

The Author Introduces —

MILITARY AIRCRAFT

By H. F. KING

PRIMARILY this issue of *Flight* is devoted to a study of international practice in the design, construction, armament, equipment and, to a lesser degree, operation, of military aircraft. It is the most thorough survey of its kind yet published, and extensive use has been made of foreign material.

The tables of data have been compiled to give as accurate an indication as possible of the characteristics of individual machines. It is emphasised, however, that many of the figures are unconfirmed, though one fact is certain: British aircraft which have been in service for a considerable period make a superb showing even against foreign prototypes, the figures for which may be highly optimistic. When it is remembered that the Hurricane and Spitfire, for example, were Great Britain's best fighters three years ago and that they still compare so well with foreign fighters of much more recent design, we get some indication of their quality. Nevertheless there are developments abroad which are well worth attention.

It is greatly to be regretted that photographs of, and data for, the newest British service types are officially withheld, though references have been published in the Continental press to a "Westland twin-engined fighter" and other intriguing machines. Another British high-speed two-engined machine has already made a brief appearance in public, but further reference to this promising aircraft is prohibited. The only permissible indication of the performance of our new fighters is that during contractors' trials one of them was dubbed "Crikey" by local residents.

It will be learned from a study of the ensuing material that despite the tendency toward specialisation of military aircraft there is one type of machine, the fast twin-engined three/four-seater, which may be adapted for bombing, fighting, reconnaissance, ground attack and, in some cases, torpedo-dropping. The general-purpose day and night single-seater fighter is also much in evidence.

Since our last Military Aircraft number some refreshing designs have appeared; these are remarked on hereafter. The increased importance attached to armour protection is also noteworthy.

It is important to bear in mind when perusing the tables of data that the figures for top speed should be linked with those for the corresponding heights. Many foreign machines are handicapped by engines which deliver their power at comparatively low altitudes. It would have been preferable to have quoted figures for, say, maximum speed at 20,000ft., but sufficient data were not forthcoming to permit this.

Finally, it is emphasised that many of the machines discussed and illustrated are prototypes only, and it should not be inferred that they are in service. They are included for their interest.

In other words, the issue deals with technical development rather than the equipment of air forces.

A MESSAGE from the AIR MINISTER

AIR MINISTRY.
WHITEHALL, S.W.1.

4th March, 1940

I welcome this opportunity of contributing a foreword to the special Military Aircraft number of "Flight" and of commending its contents to the many thousands connected with the Royal Air Force and with British aircraft manufacture.

The review of military aircraft, British and foreign, in the following pages will be of particular interest at the present time and should also have considerable educational value—not least, perhaps, from the point of view of the striking evidence it affords, to readers both at home and overseas, of the outstanding qualities of British machines.

Hungerford Hood

BOMBERS

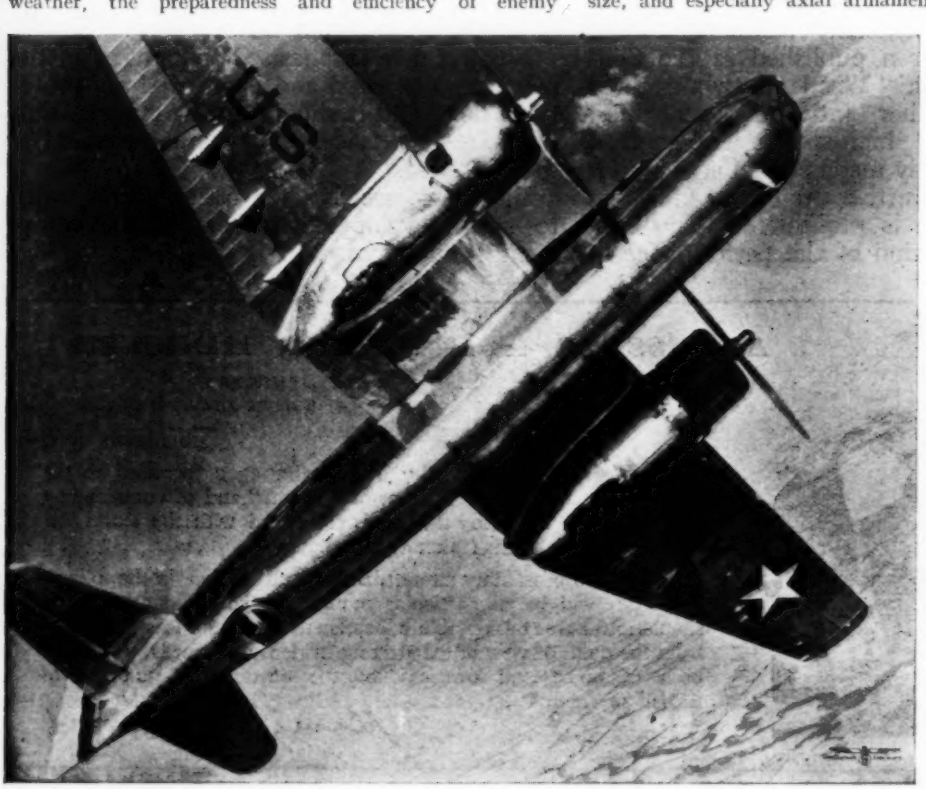
Including Multi-Purpose Aircraft Suitable for Reconnaissance and Ground Attack : Dive Bombing

ALTHOUGH the bombing aeroplane is frequently likened to a long-range piece of artillery, it must be borne in mind that a big shell, once it leaves the muzzle of a truly laid gun, is impersonal, invulnerable, irrevocable, and inevitable, whereas the bomber is guided by human brains and hands, can be destroyed, recalled, or redirected, and is dependent for success on weather, the preparedness and efficiency of enemy defences, and eventually—no matter how well navigated—on the skill of the bomb-aimer.

An efficient bomber must be able to attain, attack, and return from its target with a minimum of delay and consequently of risk. Speed, defensive fire power, and manœuvrability are desiderata, though their attainment must not be permitted to affect unduly the efficiency of a machine as a bomb carrier. The further development of specialised fighters for escort work may enable the bomber's defensive armament to be reduced or, in certain cases, omitted altogether, with a consequent gain in speed, though it must be remembered that it is not always possible, particularly at night, for aircraft to operate in company. The ideal of the tremendously fast unarmed bomber which will depend for protection entirely upon its speed remains a designer's dream, though the next few years may see it an accomplished fact.

A *Questionable Doctrine*

There are many knowledgeable strategists who contend that all bombers should be comparatively small, manœuvrable machines armed with fixed or axially restricted guns. The protagonists of this doctrine cite examples from the Spanish civil war. In particular, the French General Armengaud writes: "The fire of bombers outside the axial plane is almost impossible with the present speeds of aircraft, and it cannot, in any case, be accurate. A speed equal to that of the pursuit machine, or very near it, plenty of manœuvrability, small size, and especially axial armament—these are the conditions for the protection of bombers against aerial and terrestial weapons." The General refers to the "insufficient protection" of the big Savoia, Caproni, and Junkers bombers, and cites as proof of his argument the success of the smaller and faster Russian Katiouska and the German Dornier Do 17. It may, or may not, be significant that he refrains from mentioning the Fiat B.R.20, which, although larger than the Do 17, is as fast as the version of that



The Stearman X-100, or XA-21, a good example of what the Americans term an "attack bomber." This machine corresponds to the European formula for fast twin-engined bombers.

machine commonly used in Spain, and, what is more, carries its armament in efficient Breda power-driven turrets.

It has been suggested that the Germans drew some false conclusions from the Spanish war and that they are developing heavier armament for their bombers at the expense of speed and manœuvrability.

For short-range work the small, fast, "evasive" type of bomber, which depends mainly on its speed and manœuvrability for protection, is a practical proposition, but for long-distance operation its limitations soon become apparent. If the range is long the bomb load will be small, and there is little point in flying for very long distances if the blow delivered is not a telling one. This means that large numbers of small, fast bombers must be employed to do the work of fewer but larger machines. If the opposition is very strong this may be worth while.

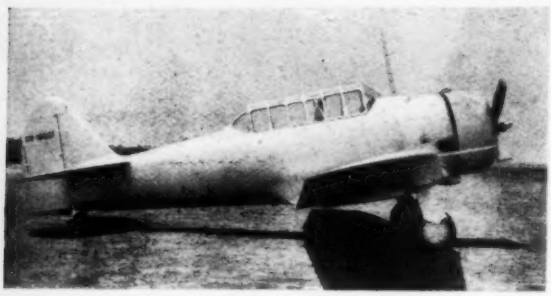
The classes of bombing aircraft in service to-day are more numerous than might be believed. Before examining their characteristics it will be advantageous to outline modern bombing technique, which, of course, strongly influences their design.

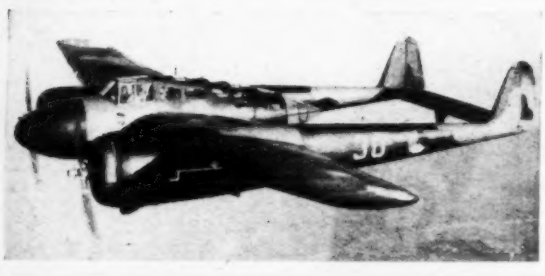
There are three commonly used types of bombing attack: the high-altitude; high-level or "precision" method; dive-bombing; and the low-level attack. The first is practised by all types, though least by specialised dive-bombers. It entails flying at very considerable heights to minimise the chances of enemy anti-aircraft guns and making a somewhat lengthy "run-up" to the target on a set course, at a steady speed and constant height while the bomb sight is adjusted. The bombs, of course, are dropped some distance before the machine reaches its target. For example, a bomber flying at 300 m.p.h. at 21,000ft. may have to release about three miles from the objective.

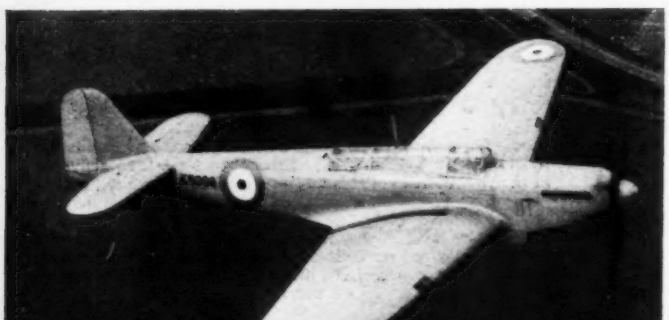
Dive-bombing implies the release of the projectile(s) at low or medium altitude at the bottom of a steep dive on

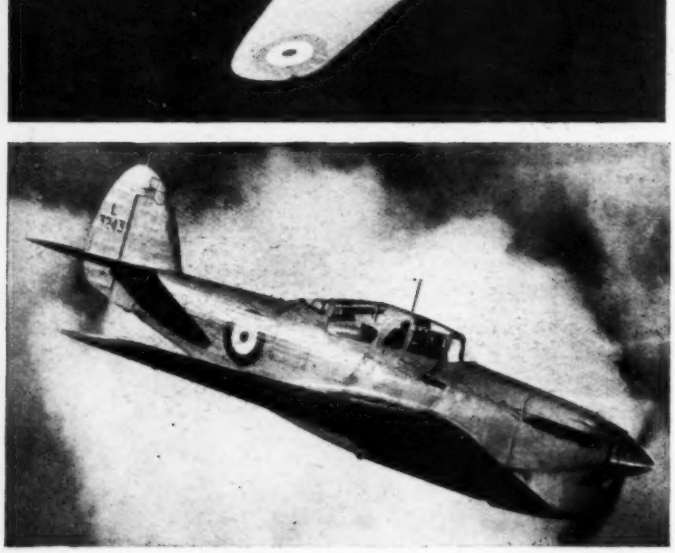
Outstanding among the world's multi-purpose aircraft is the Bristol Blenheim Mark IV. Blenheims have been delivered to the R.A.F. in hundreds and are used for bombing, reconnaissance and fighting.

One of the most successful large bombers ever built is the powerfully armed geodetic-built Vickers Wellington (below), which, on many occasions, has distinguished itself on active service.









the target. It is comparatively easy to score a hit on a fairly small target, though there is only one position for release in any dive for the path of the bomb after leaving the aircraft is not straight.

The low-level attack is made at high speed and from a low altitude without the use of bomb sight. In some cases it has been found desirable to attach each bomb to a small parachute to give the attacking machine time to clear the explosion.

Attempts have been made to increase the horizontal range of bombs by fitting them with wings ("glider" bombs); by releasing them at the beginning of a sharp climb ("zoom" bombing); and by fitting them with a propulsive agent ("rocket" bombs).

Classification

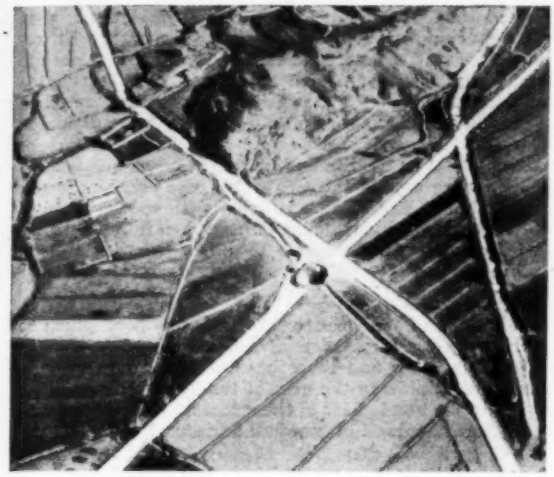
Bombing aircraft have been categorised as "night" and "day" bombers and later as "light," "medium" and "heavy" types according to load. Classification of this sort must necessarily be confined to contemporary aircraft, for the medium bomber of to-day may be the light bomber of to-morrow. Perhaps the most outstanding instance of this is provided by the Handley Page Hampden which, although frequently referred to as a medium bomber, actually carries a bigger load for a longer range (and, incidentally, at a much higher speed) than the Harrow "heavy" bomber, which was its immediate predecessor in production. Matters are further complicated because many of the bombers of intermediate size are versatile enough for classification as "multi-purpose" machines, which means that they are readily adaptable for reconnaissance, fighting or ground attack work. For the sake of convenience modern bombing machines may be classed as follows: Specialised single-seater dive-bombers (650-1,200 h.p.); specialised two-seater dive-bombers in the same power class; non-specialised single-engined two/three-seaters of similar power; twin-engined two/five-seaters (1,300-3,000 h.p.); three-engined multi-seaters (2,000-4,000 h.p.); and four-engined multi-seaters (2,800-6,000 h.p.).

Dive Bombers

Specialised dive-bombers are being studiously developed, particularly on the Continent, and larger types of non-specialised bombers are in many cases being designed with "shallow" dive-bombing in view. Yet only three years ago a high-ranking officer stated that dive-bombing was not practical in the R.A.F. because contemporary aeroplanes reached such high speeds in a dive that it would be very difficult to pull them out if, indeed, they did not break up in the air. Even later a prominent technician wrote to *Flight* as follows:—"If dive-bombing has a sufficient value to justify an appreciable loss in the performance normally required from a bomber, then the dive-bomber can most efficiently be a machine with a top speed about half to two-thirds of the required dive speed. If you want to dive-bomb from anything much faster than this you will, in practice, have to get your high speed by using an excessive engine power for the military load which it will carry. If it is a clean aeroplane with (air) brakes this will occur because the structural weight required to cope with the brake loads will be colossal and you will have to use a very large, expensive machine to carry very little useful load. And it would be more

Five dive-bombers. From top to bottom they are the Blohm and Voss Ha 137 single-seater (Germany); North American NA 44 two-seater (U.S.A.); Fokker G.1 two-seater (Holland)—this machine can be used for a variety of duties; Fairey P.4/34 two-seater (Gt. Britain); and Hawker Henley two-seater (Gt. Britain). The Henley has internal bomb stowage, though additional bombs may be carried under the wings.

BOMBERS (CONTINUED)



Germany's *Luftwaffe* obtained good results in Poland with dive-bombers. Above are crossroads after receiving attention from a Ju 87.

economical to take an old-type biplane which already had the drag required for diving and put a more powerful engine into it."

Actually, the modern dive-bomber is a clean, high-performance machine carrying a very useful bomb load without using excessive engine power.

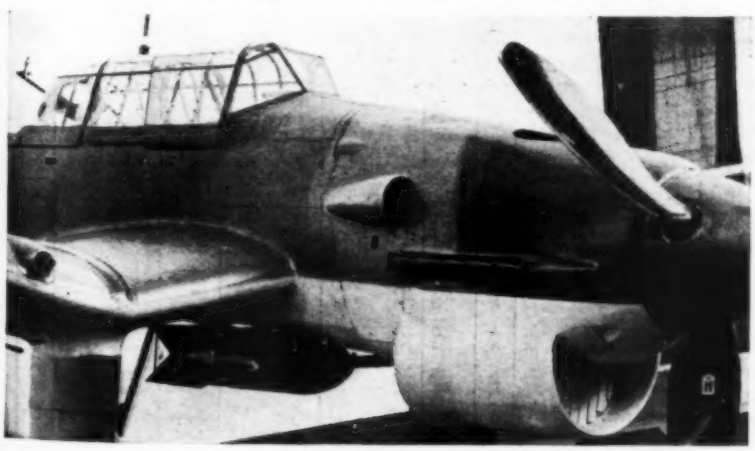
Diving Requirements

Dive-bombers must be strong enough to withstand sharp pull-outs; manœuvrable enough to make things difficult for enemy A.A. gunners; the pilot's view over the nose must be especially good; the fuel system must be specially studied, and provision made, if the machine is a single-engined type and the bomb is carried beneath the fuselage, for the projectile to be guided clear of the airscrew. Two advantages of the twin-engined layout are improvement in the pilot's forward vision and the fact that bomb-displacing gear is unnecessary. Modern specialised dive-bombers are fitted with aerodynamic brakes to retard the speed in a bombing dive which would otherwise be too high for the pilot to take accurate aim from comparatively close range. Reversible pitch airscrews have also been tried as diving brakes.

The specialised single-seater dive-bomber is comparatively new in conception although American Navy fighters have for some years been equipped to carry quite heavy bomb loads. Germany was among the first countries to give the type consideration, and the Henschel Hs 123 biplane was used in the Spanish and Polish campaigns. With its biplane wings and fixed undercarriage it does not pick up speed in a dive as quickly as the clean cantilever monoplanes and consequently does not need diving brakes.

German Henschel Hs 123 single-seater dive-bombers attacking docks during the Spanish campaign.

Most modern of the single-seater dive-bombers is the Italian Savoia Marchetti S.M.85. This is a high-wing monoplane with internal ventral bomb stowage and two radial engines of comparatively low power. The pilot sits in front of the wing and his outlook—already good—is further improved by a window in the lower section of the nose. Obviously the machine has been designed for great strength, the plywood-covered fuselage having external longitudinal stiffeners. A peculiar form of slotted flap is fitted and functions, when depressed to an angle of 90 deg., as a diving brake. A demonstration in Italy by a flight of these machines has proved that the type is very controllable even



A single large bomb is carried on an ejector fork beneath the fuselage of the Junkers Ju 87. Before a diving release the bomb is lowered on this fork in order to clear the airscrew.

when diving with flaps down. The machine has been developed into the S.M.86, which has a higher performance.

Mr. Folland advocates the adoption of a super-fast unarmed single-seater dive-bomber and maintains that such a machine could be made at least as fast (with reduced factors at the start) as an intercepter fighter despite the fact that it would have a range of 1,400 miles. One would presume in view of its cleanness (estimated top speed 470 m.p.h.) that some extremely efficient form of diving brake would be needed; possibly a reversible-pitch type of airscrew would be used in addition to aerodynamic brakes.

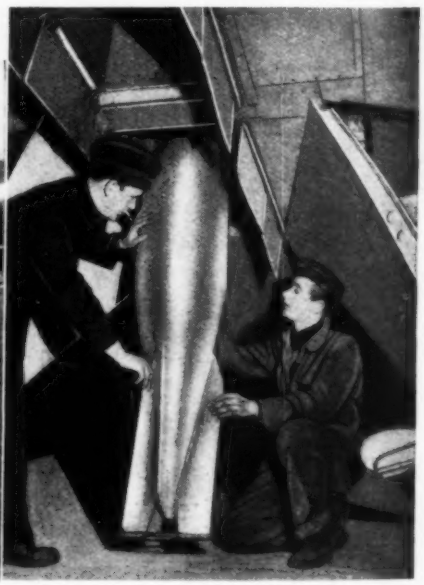
Outstanding among the two-seater dive-bombers is our own Blackburn Skua which is fitted with special hydraulically operated speed-reducing flaps. When fully depressed these limit the diving speed to about 220 knots (255 m.p.h.).

Dive-Control

Exhibitions of "dive-control" have also been given in public by two other foreign dive bombers, one a version of the Fokker G-1 and the other the Junkers Ju 87. As there is no airscrew in the nose of the Fokker the problem of guiding the bomb clear of the structure is simplified and aiming facilitated. For normal horizontal bombing the

On the left are Fairey Battles of the R.A.F. in the act of "peeling off" from an echelon formation to deliver a dive-bombing attack.

Many of the Continental bombers have vertical bomb stowage. Below on the left a Heinkel He 111K is seen being "bombed up," while on the right a large projectile is being persuaded into the bomb cell of a Ju 86K.



Dive-Bombers

Designation of Aircraft	Span	Wing Area	Wing Loading	Gross Weight	Disposable Load	Engine Type	Cooling	Rated Power	Max. Speed	Attained at	Climb To	Climb In	Service Ceiling	Typical Armament	Progress
	ft. in.	sq. ft.	lb./sq. ft.	lb.	lb.			h.p.	m.p.h.	ft.	ft.	min.	ft.		
GREAT BRITAIN															
Blackburn Skua	46 2	312	21.8	6,811	1,321	Bristol Perseus XII	A	745	225	6,500	—	—	20,200	5 rcmg	QP
Hawker Henley	47 10½	342	26.4	9,050	3,350	Rolls-Royce Merlin II	L	990	300	17,500	19,680	15	29,000	2 rcmg	IS
Fairey P.4/34	47 4½	346	25.4	8,787	2,382	Rolls-Royce Merlin II	L	990	284	17,200	—	—	29,600	2 rcmg	IP
AMERICA															
Bell BG-1	36 0	353.8	17.3	6,641	2,821	Wright Cyclone F56	A	755	206	11,300	—	—	24,950	2 rcmg	AO
Brewster XSBA-1 (138)	39 0	259	23.16	6,000	2,000	Wright Cyclone G	A	750	285	—	—	—	—	2 rcmg	IP
Curtiss SBC-4 (Helldiver 77)	34 0	317	18	5,710	1,544	Wright Cyclone G3	A	840	235	9,800	—	—	25,700	2 rcmg	IS
Douglas DB19	41 6	318.6	20.5	6,527	2,025	P. and W. Twin Wasp Jr.	A	750	223	—	—	—	25,000	2 rcmg	IS
Vought SB2U-1 (V.156)	42 0	305.3	21.3	6,500	2,000	P. and W. Twin Wasp Jr.	A	750	257	—	—	—	28,200	2 rcmg	IS
GERMANY															
Blohm and Voss Ha.137	36 7	252.8	21	5,313	1,320	Junkers Jumo 210c	L	680	205	6,560	13,120	9	22,960	2 rcmg	PA
Junkers Ju.87	45 4	344	26.7	9,200	3,000	Junkers Jumo 211	L	940	240	—	—	—	25,000	3 rcmg	IS
HOLLAND															
Fokker G.1	54 1½	384	27	11,243	3,637	Bristol Perseus X	A	1,460	300	—	19,680	11	29,000	5 rcmg	IS

Two single-engined multi-purpose machines which are similar in that they have a fixed undercarriage and twin fins and rudders. On the left is the new Swiss C.36 and on the right the Polish P.Z.L. Sum.

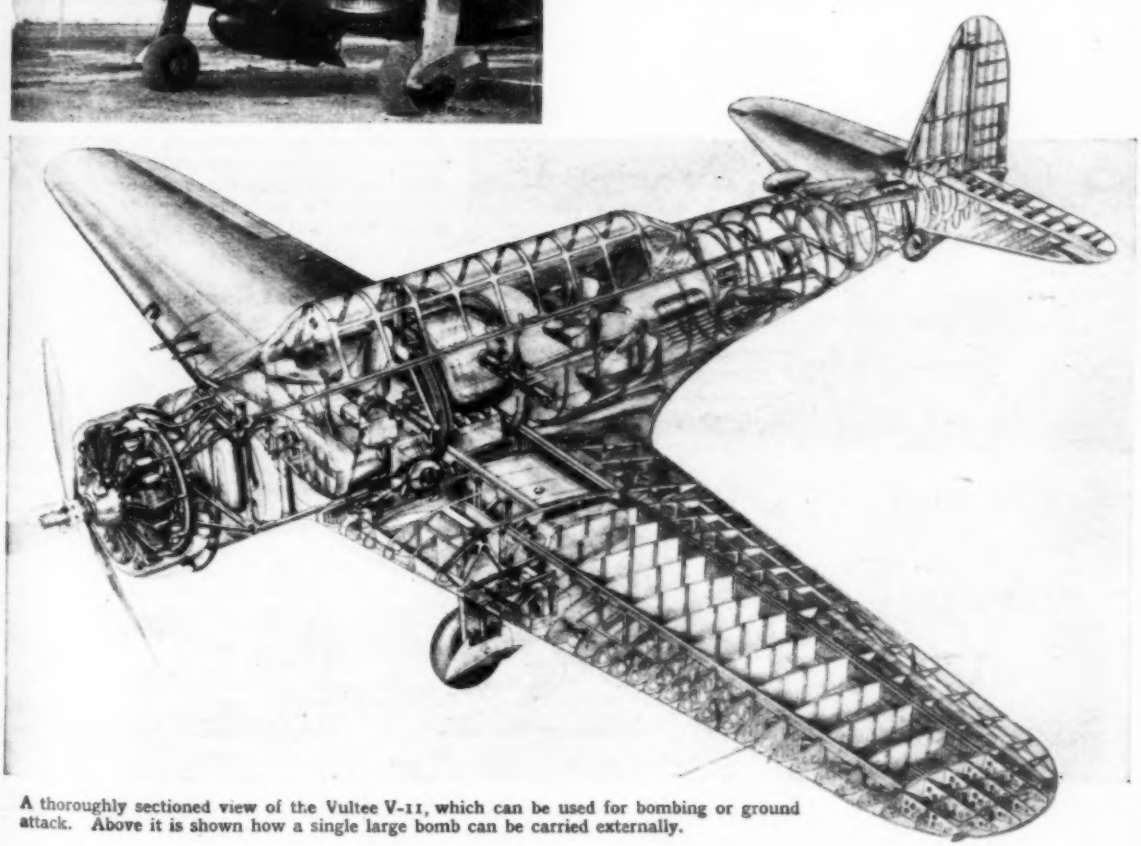
projectiles are stowed internally, but for the diving attacks the trap doors are locked in the closed position and a single bomb of 400 kg. (880 lb.) is suspended externally. The air brakes take the form of hydraulically operated slats below the wing just aft of the leading edge and it is claimed that, with these brakes in operation, 180-deg. aileron turns can easily be made over a vertical path of 2,300ft. Without the brakes a speed of 400 m.p.h. is reached. Terminal velocity dives have been continued from 13,000ft. to 3,300ft.

It is not without interest to compare the performance of the G-1 short-range dive-bomber with its external bomb with that of the normal bomber version with internal stowage. These figures relate to the machine as fitted with two Bristol Perseus X engines.

	DIVE BOMBER	NORMAL BOMBER
Bomb Load ..	880 lb.	880 lb.
Weight of Rack(s)	90 lb.	90 lb.
All-up Weight	11,240 lb.	11,900 lb.
Top speed	301 m.p.h.	298 m.p.h.
Climb to 19,685 ft.	10.9 min.	12.2 min.
Ceiling	30,180 ft.	29,200 ft.
Range	560 miles	890 miles

The Ju 87 has brakes which are generally similar to those on the G-1, though they are in four, instead of two, sections. Concerning this machine the manufacturers remark: "The diving speed can be limited by a diving brake. This means for limitation is not incorporated as a protection against structural failure, as requisite possibly in other designs of dive bomber, but solely in thorough appreciation of tactical requirements for effective employment of dive bombers. The brake makes it possible to approach the target closely without the crew experiencing excessive acceleration when levelling out and suffering deterioration in aiming. The aircraft can be pulled out of the fastest dive with full load and with diving brake off, in perfect safety."

A single large bomb of 550 or 1,100 lb. is carried on a deflector fork beneath the fuselage. Four additional bombs of 110 lb. each may be slung beneath the wings, though these may displace the second member of the crew.



A thoroughly sectioned view of the Vultee V-11, which can be used for bombing or ground attack. Above it is shown how a single large bomb can be carried externally.

TWIN-ENGINED MULTI-PURPOSE MACHINES

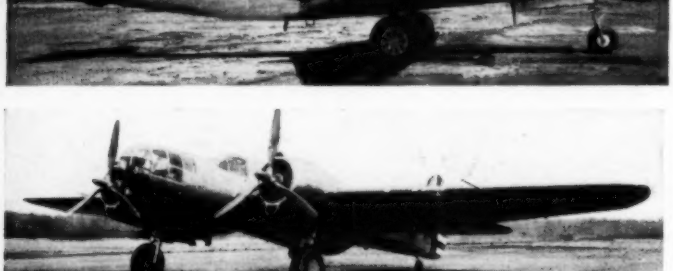
Designation of Aircraft	Span	Wing Area	Wing Loading	Gross Weight	Disposable Load	Engine Type	Cooling	Rated Power	Max. Speed	Attained at	Climb To	Climb In	Service Ceiling	Typical Armament	Progress
	ft. in.	sq. ft.	lb./sq. ft.	lb.	lb.			h.p.	m.p.h.	ft.	ft.	min.	ft.		
GREAT BRITAIN															
Bristol Blenheim I (Bomber)	56 4	469	26.6	12,500	4,400	Bristol Mercury VIII ...	A	1,680	285	15,000	20,000	17.5	27,280	2 rcmg	IS
Bristol Blenheim IV(Bomber)	56 4	469	26.6	14,400	6,150	Bristol Mercury XV ...	A	1,680	295	15,000	20,000	17	—	2 rcmg	IS
FRANCE															
Bloch 174 (Recco.) ...	58 7	441	—	—	—	Gnôme-Rhône 14N ...	A	1 740	310	18,000	—	—	—	3 rcmg	IP
Breguet 690 (Fighter) ...	50 6	314.2	30.54	9,570	3,168	Gnôme-Rhône 14M ...	A	1,460	304	16,400	13,120	7	30,500	2 sg 1 rcmg	IS
Potez 63 (Fighter) ...	52 6	355.2	23.8	8,470	2,627	Gnôme-Rhône 14M ...	A	1 460	285	13,120	13,120	7.3	30,000	2 sg 1 rcmg	IS
AMERICA															
Martin 167	61 4	538.5	28.4	15,297	4,711	P. and W. Twin Wasp ...	A	2,000	316	14,000	—	—	31,000	6 rcmg	IS
North American NA.40 (Attack).	66 0	598.5	35.0	21,000	7,450	Wright Two-Row Cyclone	A	2,400	314	17,500	—	—	26,500	7 rcmg	IP
GERMANY															
Dornier Do.17 (Bomber) ...	59 0	592	30.02	17,857	7,408	Daimler-Benz DB600G ...	L	2,100	290	13,120	—	—	—	2 rcmg	IS
Dornier Do.215 (Bomber) ..	59 0	592	31.9	18,920	7,260	Daimler-Benz DB601A ...	L	2,100	310	—	—	—	29,500	3 rcmg	IS
BOHEMIA-MORAVIA															
Aero A-300 (Bomber) ...	62 11	489.6	27.26	11,088	4,587	Bristol Mercury IX ...	A	1,650	291	18 040	19,680	11.5	24,600	2 rcmg	PA
HOLLAND															
Fokker G.1 (Bomber) ...	54 1½	384	29	11,900	4 343	Bristol Perseus X	A	1,460	298	—	19,680	12.2	28,000	5 rcmg	IS
YUGOSLAVIA															
Ikarus Orkan (Fighter) ...	43 5	279.5	29.9	8,360	3,300	Hispano-Suiza 14AB ...	A	1 310	341	13,120	13,120	4.3	35,000	3 rcmg	PA

Certain dive-bombers used by the U.S. Navy have diving brakes which take the form of split trailing edge flaps opening like two leaves of a book.

Apart from the Blackburn Skua no Britsh bombers designed with the diving attack in mind have been fitted with diving brakes, though special arrangements are made to guide the bombs clear of the airscrew. On the Fairey Battle, for example, the internally stowed bombs are carried on hydraulic jacks which are retracted into the wing. When released the projectiles fall through trap doors except in the case of dive-bombing when they are lowered beneath the wing surface. It is stated that the normal bomb load is 1,000 lb., though allowance is made for a 500 lb. overload.

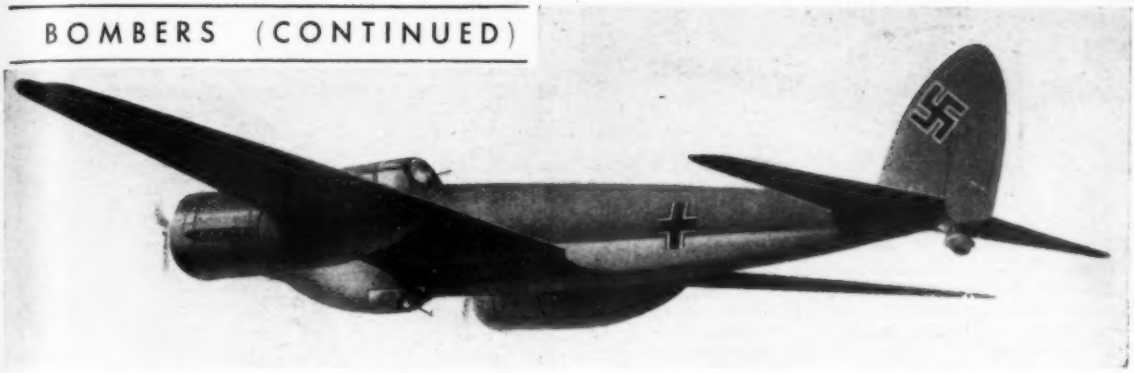
The Battle, although classed by the R.A.F. as a bomber, is a good representative of the single-engined multi-purpose class. The term "multi-purpose" (not to be confused with the old R.A.F. classification "general purpose") embraces a large variety of machines weighing betwen 6,500 lb. and 15,500 lb. which can be used for bombing and reconnaissance. The smaller machines are also suitable, when specially adapted, for fighting or ground attack and certain of the larger may be equipped, in addition, for torpedo-dropping.

The single-engined multi-purpose bomber is popular among impecunious nations with small air forces, though it is still justifying itself in the service of the Powers. There is, however, a marked tendency to fit at least two engines to all bombers, though the single-seater unarmed ultra-high-speed machine may, as already inferred, mark a reversion to a single engine.



Probably the most versatile high-speed twin-engined machine in the world is the Bristol Beaufort (below). The Beaufort could be used for bombing, reconnaissance, torpedo-dropping, fighting and ground attack. Of the two machines on the left the one with the tricycle undercarriage is the Douglas DB-7. This machine, like the Martin 167 below it, has been supplied in quantity to France.

BOMBERS (CONTINUED)



Germany's new Junkers Ju 88 high-speed twin-engined bomber. There is probably internal stowage, but it is certain that bombs are also carried beneath the centre section. It is believed that the type can be used for dive-bombing.

There are various reasons for the adoption of two engines for medium-sized bombers. Mainly these are operational, though the problems of airscrew diameter and undercarriage height apply to a certain degree. Particularly in the case of the smaller multi-purpose bombers which can be used as fighters the possibility of installing heavy forward-firing armament is a governing consideration, while the poor forward view, greater complication in the fuselage, vibration, and the difficulty of providing a forward position for the bomb-aimer are other weighty factors militating against the single-engined machine. On the other hand, the fitting of two engines on the wings has certain drawbacks, notably transference of weight outboard with consequent loss in manœuvrability (this may be partially offset by counter-rotating airscrews) and, in the case of certain mid- and high-wing radial-engined machines of comparatively small size, notoriously bad lateral vision.

Aerodynamically, some of the latest multi-purpose bombers, being the fastest of all bombing machines, are a joy to behold, though military requirements necessarily mar their lines. Design varies considerably, low, mid and high wings all being in vogue. Radial engines predominate, for the time being at least.

Although profiting from the same technical advances as high-speed transport aircraft, the structural design of fast bombers may differ considerably as stresses will be concentrated in the bomb cells rather than distributed along the length of the fuselage. Metal-stressed-skin construction is most favoured and on a number of new types a tricycle undercarriage is fitted. Another point of technical interest is the extensive use of beautifully moulded transparent material in the nose. In some types the entire forward part of the fuselage is almost completely transparent, giving an excellent view for the pilot and observer and light for the bomb-aimer.

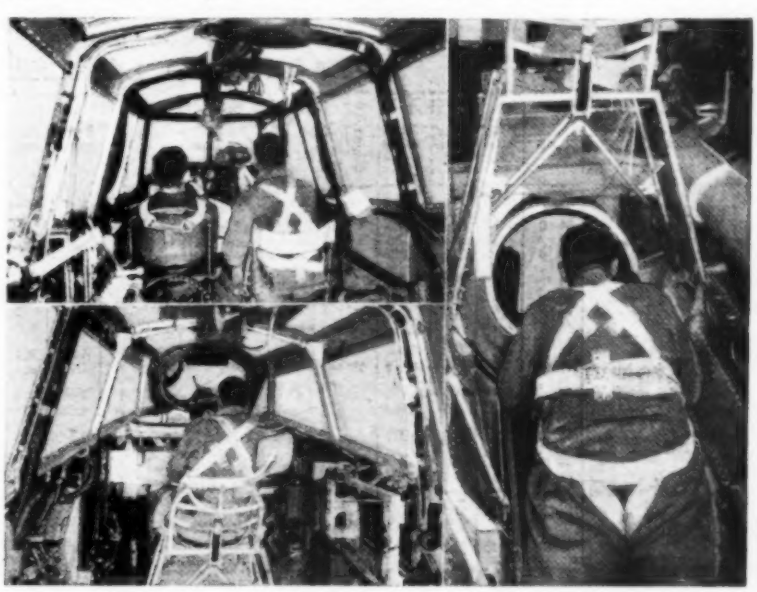
While our Bristol Blenheim and Beaufort have a comparatively roomy cabin extending aft from the pilot's cockpit to a power-driven gun turret the French Potez 63, being a lighter machine and having a fuselage of smaller cross-section, is laid out rather on the lines of the Fairey Battle with an external transparent enclosure. For bombing operations, a crew of two is carried in the Potez, the third man's position being taken up by a cell holding eight 125lb. bombs. One version of the machine has external racks for dive-bombing.

Regulations prevent our referring to the bomb load of the Blenheim or Beaufort so we must turn to the new Martin 167 for an examination of the bomb arrangements. Internal racks are fitted to carry one 1,130lb. bomb; two 624lb. bombs; four 308lb. bombs; or eight 116lb. bombs. These are released through doors in the bottom of the fuselage which are opened by elastic cords and closed by hydraulic power from either the pilot's or the bomb-aimer's position. For ground attack work a large number of small fragmentation bombs are carried in chutes in the bomb bay, supplementing four wing-mounted guns and two free guns.

Gun Installations

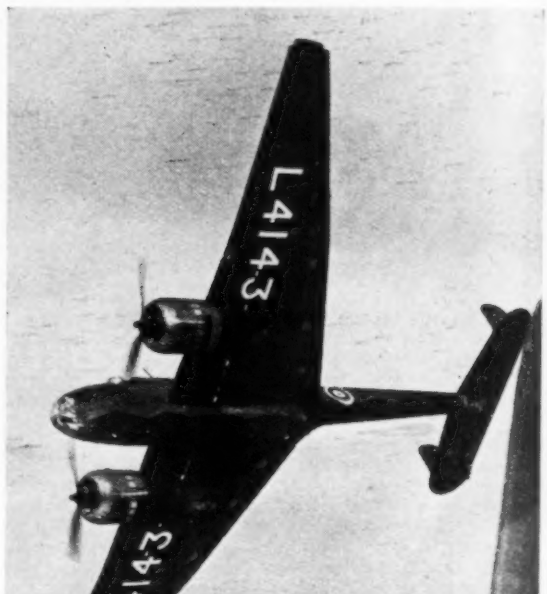
Armament, despite the limitations imposed by the comparatively small size of the machines under consideration, differs fairly considerably, though when they are operating exclusively as bombers the fire power is not very heavy.

The standard Blenheim bomber has one fixed wing-mounted gun and a second weapon in a semi-retractable power-driven turret aft of the cabin; the Czech Aero A-300 and the Italian Caproni Ca 135 likewise have a retractable turret, but the front gun is mounted in the nose and has a limited arc of fire; the Potez, Breguet and Breda machines, when functioning solely as bombers, have fixed machine guns, plus one aft gun with a restricted arc of movement. Germany's Dornier Do 215 has a gun with a very restricted movement firing through the pilot's windscreen, a second on top of the fuselage and a third below. The Do 215 is also of interest in that the crew is bunched together in the forward part of the machine in front of the bomb compartment.



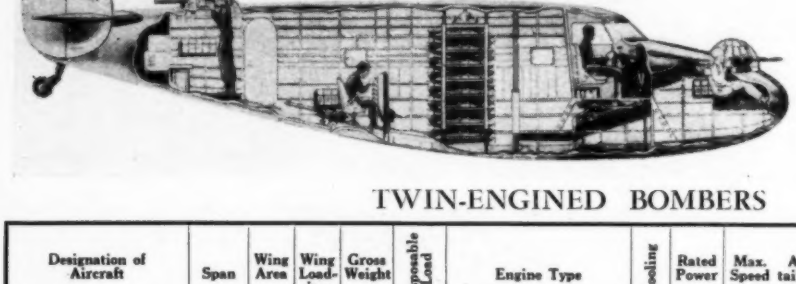
On the right are three interior views of the German Dornier Do 215. In two of the views the upper and lower rear guns are shown manned.

BOMBERS (CONTINUED)



It will have been gathered from our reference to the Martin 167 that even in the "ground-attack" condition the gun-power is comparatively low. The modern tendency is to use bombs for low-flying attacks rather than machine guns. America's new formula for twin-engined "attack" bombers corresponds in fact to the European conception of a compact, high-performance, twin-engined bomber. In this connection the remarks of Brig. Gen. Jacob Fickel, Commanding General, First Wing, G.H.Q. Air Force, U.S. Army Air Corps, are of interest. He writes that the Ethiopian and Spanish wars increased the demand for aircraft suitable for close support of ground forces by attacks on hostile rear areas. He refers to the technical difficulties in the development of the low-flying attack machine and states that these, coupled with the improvement in ground fire against that type, led to the development of the 'tack bombers, or, as he chooses to call them, "light bombardment airplanes." Brig. Gen. Fickel states that although the machines have a comparatively short range when carrying a full bomb load they can fly far enough to deliver heavy attacks from an altitude out of effective reach of small arms and machine guns on hostile reserves, ammunition and supply dumps, lines of communications, command posts, mechanised flanking forces, and advanced aerodromes.

The highly specialised ground-attack machine has lost favour, though the Curtiss 76-D is available with eight fixed guns and a rear free gun. In the fuselage is stowage for twenty chemical or fragmentation bombs, while racks on each side of the centre section carry two 100lb. bombs. Like all ground-attack machines the 76-D is designed for



The Handley Page Hampden bomber (above) is extremely efficient, due in a large measure to the installation of Handley Page slots and flaps. The Hereford (top left) is similar except for the engines, which are 24-cylinder Napier-Halford Daggers.
A good example of a bomber adapted from a commercial machine is the Lockheed 14 (left).

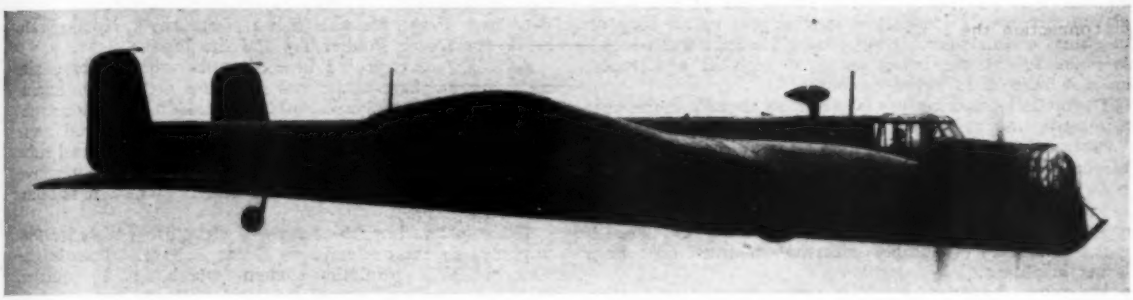
TWIN-ENGINED BOMBERS

Designation of Aircraft	Span	Wing Area	Wing Loading	Gross Weight	Disposable Load	Engine Type	Cooling	Rated Power	Max. Speed	Attained at	Climb To	Climb In	Service Ceiling	Typical Armament	Progress
	ft. in.	sq. ft.	lb./sq. ft.	lb.	lb.			h.p.	m.p.h.	ft.	ft.	min.	ft.		
GREAT BRITAIN															
A.W. Whitley	84 0	1137	22.7	25,900	8,380	Rolls-Royce Merlin	L	1,980	245	16,250	15,000	16	25,000	5 rcms.	IS
Handley Page Hampden	69 2	668	28.1	18,756	6,976	Bristol Pegasus XVIII	A	1,500	265	15,500	15,000	18.9	22,700	4 rcmg	IS
Vickers Wellington	86 0	839.5	29.6	24,850	—	Bristol Pegasus XVIII	A	1,500	265	17,000	15,000	18	26,300	5 rcmg	IS
FRANCE															
Amiot 350	74 10	721.6	26.8	19,400	—	Hispano-Suiza 12Y29	L	1,820	310	16,400	13,120	8	30,000	3 rcmg	IP
Amiot 351	74 10	721.6	26.8	19,400	—	Gnôme-Rhône 14N	A	1,740	310	16,400	13,120	7	30,000	3 rcmg	IP
Bloch 134	72 9	678	31.8	21,604	—	Hispano-Suiza 14Aa	A	2,240	273	13,120	—	—	26,240	3 rcmg	OP
Lioré 45	73 9½	731.6	32.1	23,479	9,435	Hispano-Suiza 14Aa	A	2,240	310	16,400	13,120	10	26,500	1 sg 2 rcmg	IS
AMERICA															
Martin 166	70 2	682	23.3	15,894	5,302	P. and W. Twin Wasp	A	1,800	268	6,500	—	—	24,800	3 rcmg	AO
Lockheed EB-14	65 6	551	33.6	18,500	5,850	Wright Cyclone	A	1,500	284	15,000	—	—	25,000	3 rcmg	AO
GERMANY															
Heinkel He111K (Mark V)	74 3	943	26.5	25,000	—	Junkers Jumo 211	L	1,880	270	12,300	13,000	17	24,000	3 rcmg	IP
Junkers Ju.86K (mod.)	73 9	882.3	20.5	18,100	—	B.M.W. 132	A	1,600	233	8,500	—	—	23,300	3 rcmg	OP
POLAND															
PZL Los	56 0	571	32.8	18,739	—	Gnôme-Rhône 14N	A	1,740	304	16,700	—	—	22,900	3 rcmg	OP
ITALY															
Breda 82	68 11	—	—	—	—	Fiat A.80.Rc.41	A	2,000	264	—	—	—	30,000	3 rcmg	PA
Caproni Ca 135	61 8	645.6	25.21	16,225	6,325	Isotta-Fraschini XI.Rc.40	L	1,800	273	14,760	13,120	11.5	22,960	3 rcmg	IS
Caproni Ca 405 (Procellaria)	59 0	—	—	24,200	—	Isotta-Fraschini XI.Rc.40	L	1,800	261	14,760	—	—	23,000	3 rcmg	PA
Fiat Br 20	70 6	796	27.9	22,220	7,920	Fiat A.80 Rc.41	A	2,000	268	16,400	13,100	14	29,500	3 lbmg	IS
Piaggio P32 (Mark II)	59 0	635	32.1	20,350	6,710	Piaggio P.XI.Rc.40	A	2,000	264	16,400	13,120	15	26,000	3 rcmg	IS
HOLLAND															
Fokker T5	62 10	710.5	21.84	15,983	5,732	Bristol Pegasus XXVI	A	1,660	259	—	16,400	14.2	25,000	5 rcmg	IS

BOMBERS (CONTINUED)

One of the most recent twin-engined bombers is the Fokker T.9 (right), a large machine with two Bristol Hercules 14-cylinder sleeve-valve engines.

Below is the Merlin-engined Armstrong-Whitworth Whitley bomber. This type has done magnificent work over Germany.



performance at low altitudes; the top speed at 4,500ft. is 252 m.p.h.

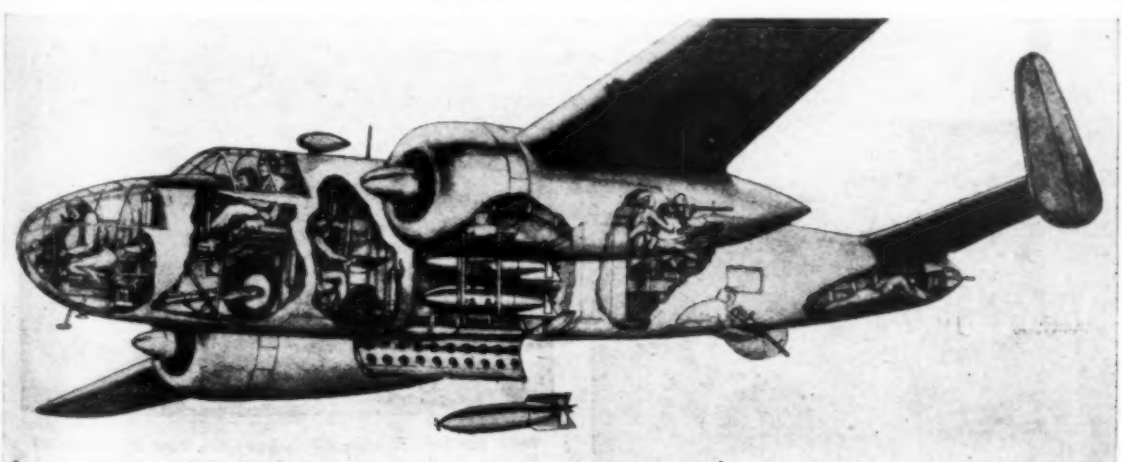
In Poland the Germans used Messerschmitt Me 110 twin-engined fighters armed with 20 mm. shell-guns for attacks on trains. A group of Messerschmitts would perforate the boilers of the locomotives with their shell-guns, the train subsequently being destroyed by dive-bombers. The Daimler-Benz DB 601 engines of the Me 110 have two-speed superchargers which confer a good performance near the ground.

Although the long-distance trips made over Germany by the R.A.F. in large, comparatively slow bombers are referred to as reconnaissance flights, long-distance daylight reconnaissance is normally undertaken by fast twin-engined machines of the type already discussed. For this sort of work the machines are fitted with cameras, and in some cases, if visibility is restricted by a part of the structure, are provided with a special compartment beneath the fuselage for the observer. A transparent nose is, however, usually considered sufficient for observation.

Large high-altitude cameras and/or extra tanks may be fitted in the bomb bay; the Dornier Do 17, for example, when undertaking reconnaissance, carries a battery of three cameras in the bottom of the fuselage. The French version of the Martin 167 is delivered with extra tankage and special photographic arrangements for reconnaissance work.

For night reconnaissance special apparatus such as the Fairchild night photographic equipment may be used. This equipment was for many years kept secret by the U.S. Army Air Corps. It consists of three principal units: a special camera, a light-sensitive cell, and an electric control box. The high-intensity flash charges which give brilliant flashes of light and deafening detonations are completely consumed in bursting, and provision is made to ensure positive action at a predetermined interval after the release of the charge, this being the time when it is well below and behind the machine. Means are also provided to prevent a premature explosion. It is said that the heavy charges of flashlight powder have a million times the intensity of ordinary photographic flash bulbs.

As for speed, it was considered astonishing years ago that Mr. C. R. Fairey could build a bomber (the Fox) which could "walk away" from many contemporary fighters. The fast twin-engined multi-purpose bombers of to-day in some instances approach fighter performance, but are not as fast as might be expected. Greater speeds would un-



The North American NA-40A bomber has fixed guns in the nose and free guns above and below the fuselage and in the tail. The view above also shows the bomb stowage arrangements.

Italy is the only country which favours the three-engine formula for large bombers. On the left is the Savoia-Marcoetti S.M.79B and on the right the Cant Z.1007.

doubtedly be attained in many instances if liquid-cooled engines were adopted. Buried power plants and shaft-driven airscrews or propellers may appear before long on machines of this class. Higher wing loadings will necessitate the fullest use being made of high-lift equipment, assisted take-off or aerial refuelling.

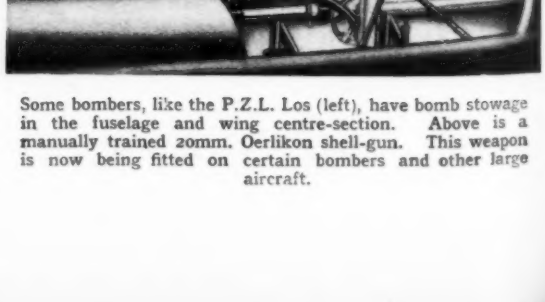
Dogmatists often discuss bombers as though there were a clearly defined division between the small, fast "evasive" types and the larger, more heavily armed machines which rely primarily for protection on their gun power. Actually, as we have seen, some of the smaller bombers have quite a powerful armament (installed in some cases in power-driven turrets, despite the weight) which compares favourably with that mounted on certain larger machines.

We must, however, establish some rough classification for discussion and may conveniently consider the two- and three-engined machines weighing, more or less, between 18,000 and 25,000lb. Current machines of this calibre include the Handley Page Hampden and Hereford, the Vickers Wellington and Armstrong-Whitworth Whitley, France's Amiot 340 and Liore 45, Italy's Fiat B.R.20 and Savoia Marchetti S.79 and S.79B, the American Douglas B-18 and B-23, Russia's S.B-2, Germany's Heinkel He 111K, the Dutch Fokker T.5 and the Japanese.

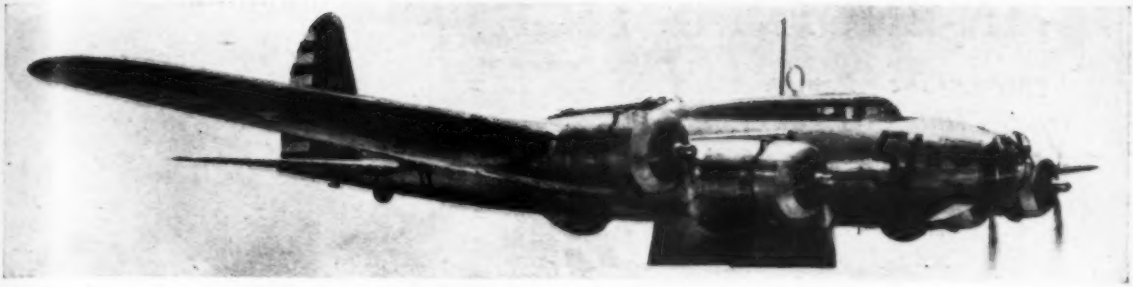
As might be expected in conformity with military aircraft the bombers under consideration are almost exclusively cantilever monoplanes. Stressed-skin metal construction is generally favoured, though Italy has achieved some creditable results with wooden wings and welded steel-tube fuselages. Composite construction may, in fact, yet prove to be by no means the "back number" which it is commonly considered.

There is one important type of structure which is, fortunately, so far exclusive to Great Britain. This is the Vickers-Wallis geodetic system which, using curved diagonal members, reconciles great stiffness and strength with a very low structural weight. It also permits the construction of wings of high aspect ratio which make for good take-off, climb and a high ceiling. Internal accommodation, moreover, is much less obstructed than with more conventional types of construction.

Great Britain has developed the power-driven gun turret to a very high pitch of perfection. On the left is the nose installation in the Vickers Wellington ; in the centre an experimental power-driven turret on an American Douglas B-18 ; and on the right a Breda turret on Italy's Fiat B.R.20.



Some bombers, like the P.Z.L. Los (left), have bomb stowage in the fuselage and wing centre-section. Above is a manually trained 20mm. Oerlikon shell-gun. This weapon is now being fitted on certain bombers and other large aircraft.



The Boeing B-17 (top) is shown with bomb traps open. Below it is the Boeing XB-15, the largest bomber in the world. The machine with the tricycle undercarriage is the new Consolidated bomber which is claimed to have a wing of exceptional efficiency.

Cabin supercharging will naturally influence design just as with commercial aircraft. This novelty, furthermore, will introduce some serious problems in connection with armament, though supposedly "remedial" patents have already been taken out for remotely controlled and sealed turrets.

Space does not permit a very thorough examination of the equipment and internal arrangements, apart from armament, of a large modern bomber. Taking the Wellington as being fairly typical, however, we find that this is normally manned by a crew of four: pilot; front gunner (who is also the bomb-aimer or navigator); a wireless operator (who acts alternatively as the midships gunner); and a rear gunner. A fifth, or even sixth, man is sometimes carried. Running the length of the fuselage is a catwalk. The cabin is well lighted by side windows and provided with emergency exits. In addition to an elaborate wireless and D./F. installation, the machine disposes comfortable navigating facilities, automatic controls, lavatory, rest bunk, inflatable dinghy, stowage for ten thermos flasks, sea markers and flame floats, retractable landing lights, parachute flares and formation-keeping lights. A hot-air duct runs the length of the fuselage and the machines are sound-proof.

Typical normal bomb loads for a bomber of 23,000 lb. all-up weight would be two bombs of 1,100 lb.; five at 550 lb., or twelve of 220 lb. Stowage is vertical or horizontal, though the latter is favoured. Loadings can, of course, be varied very considerably according to the nature of the target to be attacked and the type of bomb to be used. Apart from the common high-explosive bombs there are armour-piercing and semi-armour-piercing types, incendiaries, gas bombs, and certain secret designs. Armour-piercing and semi-armour-piercing have strengthened castings, reducing the explosive content. The small incendiaries are usually carried in special containers and released in showers.

Defensive armament schemes vary widely. Manually operated guns must, due to the high speeds attained, have a limited arc of fire no matter how carefully the gunner is shielded, and for the larger types of bomber power-driven turrets are finding increasing favour. The best-armed bombers of their size in the world are undoubtedly the Vickers Wellington and the Armstrong-Whitworth Whitley, which have two or three Nash and Thompson-powered turrets. Patents have been taken out for retractable top-fuselage turrets and remotely controlled turrets. Remote control permits the gunner to be situated in a comparatively safe part of the fuselage where he may be protected by armour plating. Moreover, the best sighting position may be adopted and the best firing position for the guns. The size of the actual turret is reduced and the gunner's position may be more accessible.

As explained by Capt. Frazer Nash in a recent article in *Flight*, the control of power-driven turrets must be accurate and sensitive and require a minimum operative effort. The apparatus must be as light as possible, and there must be a considerable power reserve. Variation from full speed in one direction to full speed in another must be provided for, and for any speed control setting it must maintain more or less constant speed under great variations, or even reversals of mechanical load. During the development of the Frazer Nash turrets, pneumatic (as used by the Italians) or mechanical operation were considered as alternatives, the two practical types of drives being electrical and hydraulic or some combination of the two. The hydraulic system was adopted with very gratifying results. In the

(*Concluded on page* 246.)

TWIN-ENGINED FIGHTERS

Representative Examples from Italy, Germany, America and France

Drawings by "J.P."

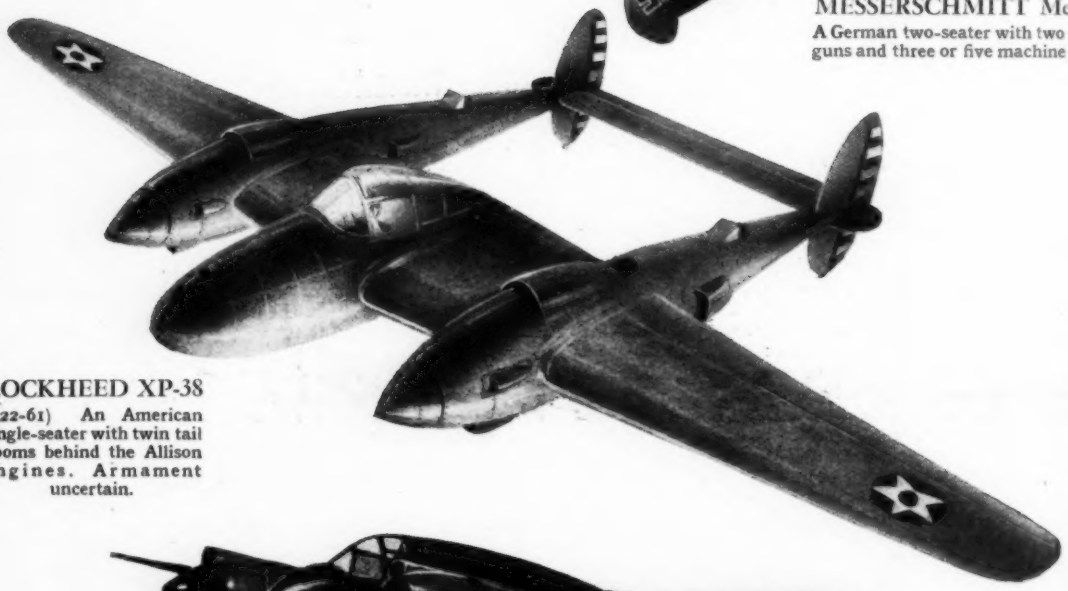
(Not to scale)

BREDA 88

An Italian multi-purpose machine which, armed with four heavy machine guns, can be used as a fighter.

MESSERSCHMITT Mc 110

A German two-seater with two shell-guns and three or five machine guns.



LOCKHEED XP-38

(322-61) An American single-seater with twin tail booms behind the Allison engines. Armament uncertain.

BREGUET 690

France's versatile multi-purpose machine which, armed as a fighter, has two shell-guns and two or more machine guns.

SHIP-BORNE AIRCRAFT (CONTINUED)

A trio of deck-landing torpedo bombers. On the left is Germany's Fieseler Fi 167 (Daimler-Benz DB 601A); above is the American Douglas TBD-1 (P. and W. Twin Wasp); and below is the Fairey Albacore with sleeve-valve Bristol Taurus. The Albacore and TBD-1 are both standard types and the Fieseler may be used on the carrier *Graf Zeppelin*.

tion and the structure must be specially treated against the corrosive action of the sea air. Hence the increasingly wide use of stainless steel. If the fuselage is not made watertight, as in the Blackburn machines supplied to the Fleet Air Arm, flotation gear in the form of air bags must be fitted. An inflatable dinghy is another necessity.

Although a large percentage of deck-landing machines in use to-day have a normal type of fixed undercarriage it is advantageous where possible to incorporate a retractable gear not only to improve performance but to facilitate forced descents on to the water. For many years on some of their larger machines the French have fitted undercarriages which can be discarded completely if a forced descent is imminent. A similar arrangement is incorporated on the new German Fieseler Fi 167 torpedo bomber, though this type lacks the "planing bottom," and wing floats which also characterise the old French Levasseur biplanes.

As simplicity and ease of maintenance are desirable, air-cooled engines predominate in naval aircraft though liquid-cooled Rolls-Royce power plants have given excellent service in Fleet Air Arm machines. The sleeve-valve Bristol Perseus and Taurus give Great Britain a marked advantage in this respect.

The most modern single-seater, ship-borne fighter aircraft which it is permissible to mention are the Grumman and Brewster types adopted by the U.S. Navy. These mid-wing, radial-engined monoplanes have a retractable undercarriage which not only permits a performance approaching that of corresponding fighters designed for operating over land, but allows the machines to be "ditched," or set down on the water, in comparative safety should the necessity arise.

Outstanding among two-seater fleet fighters is the Blackburn Roc, as used by the Fleet Air Arm. This machine is closely related to the Skua fleet fighter dive-bomber, but whereas the Skua has fixed guns and a manually operated gun in the rear cockpit, the Roc has a Boulton Paul multi-gun power-driven turret similar to that on the Defiant. With its powerful armament a machine like the Roc should be able to engage any type of carrier-borne aircraft on more than equal terms. A particular advantage of the turret-mounted armament is that, were the Roc attacking a low-flying machine, it could be flown alongside, above or ahead of its adversary and bring its armament to bear.

As already explained, some of the smaller dive-bombers

Germany has developed a variety of types for naval catapult work. The upper left-hand machine is a twin-float Arado as carried on the "pocket battleship" *Graf Spee*, and to the right of it is a central-float version of the same machine. Below the twin-float Arado is the central-float Vought-Sikorsky OS2U-1, now in production for the U.S. Navy. This type was designed to the same specification as the Curtiss XSO3C-1 (right), which has a Ranger vee-twelve engine.

SHIP-BORNE AIRCRAFT (CONTINUED)

are quite useful as two-seater fighters. The dive-bombing attack is, of course, of particular value in marine operations. A 500-lb. or 1,000-lb. armour-piercing bomb can be carried on the newer types which, being of clean design are fitted with diving brakes (these have already been discussed in the article on Bombers) and in some cases reversible-pitch airscrews.

The American single-seater Navy fighters are designed to carry a bomb-load of about 475 lb. though special diving brakes are not fitted. France has a number of Gourdon-Lesseure single-seater dive-bombers which, being developed from an old type of high-wing strut-braced fighter have a low performance and do not need diving brakes.

Some years ago the Loire-Nieuport concern built a two-seater dive-bomber fighter to the Skua formula. This machine, however, pulled its wings off in diving tests and a revised version was built with a single seat and retractable undercarriage. The struts bracing the centre section could be turned broadside on to the airstream to act as aerodynamic brakes.

Dimensional Restrictions

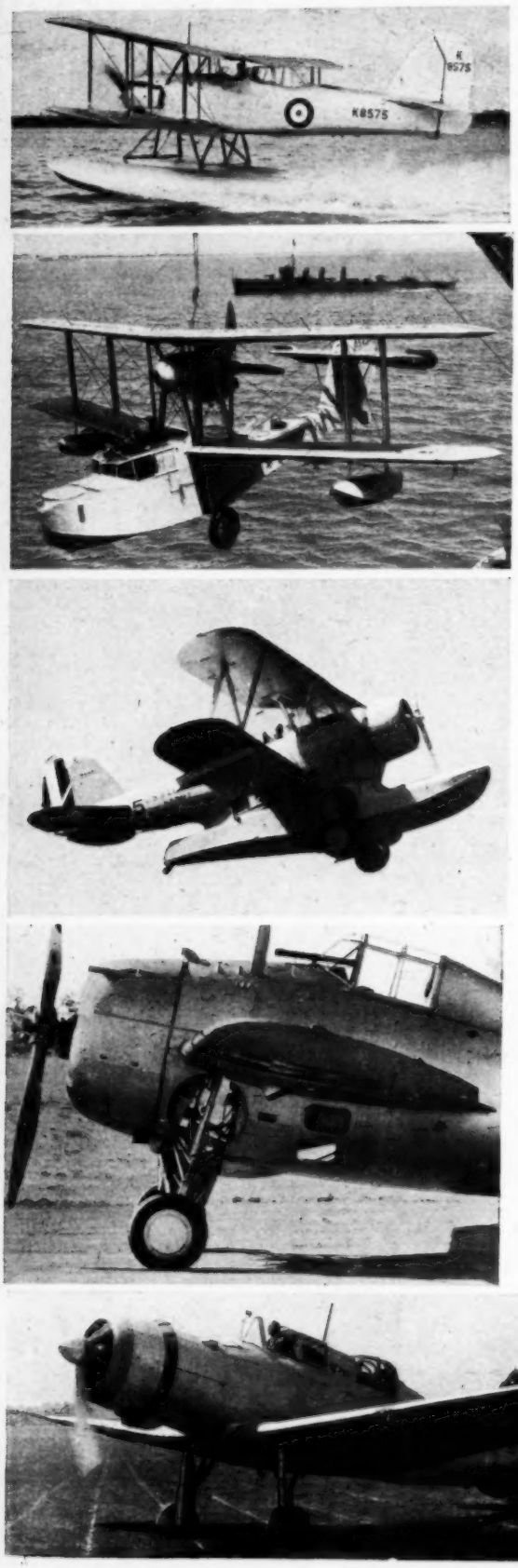
The majority of deck-landing torpedo-carriers (torpedo-bombers) are biplanes because of the restriction on overall dimensions, but for a considerable time the American Navy has used the Douglas TBD-1 a low-wing cantilever monoplane with folding wings.

If the torpedo is not carried a single large bomb can be carried beneath the fuselage on an ejector fork or a number of smaller bombs can be fitted in the wings.

Germany's first attempt at a torpedo-bomber ship-plane, the Fieseler Fi 167, is a two-bay biplane obviously designed with particular regard to low landing speed. Automatic slots extend not only over the entire leading edge of the upper wings, but over the outer panels of the lower wings which latter also embody slotted camber-changing flaps. Apart from the "droppable" undercarriage, an interesting point is the liquid-cooled Daimler-Benz DB 601 engine. The projectile load may be made up as follows: one large torpedo or two bombs of 1,100 lb. each, or four bombs of 550 lb. each.

Current types of aircraft for reconnaissance and spotting are of conventional layout though the Dewoitine company has designed a twin-engined deck-landing monoplane utilising inverted air-cooled power plants, with an under-slung compartment for the observer. This arrangement has already been referred to under "Army Co-operation."

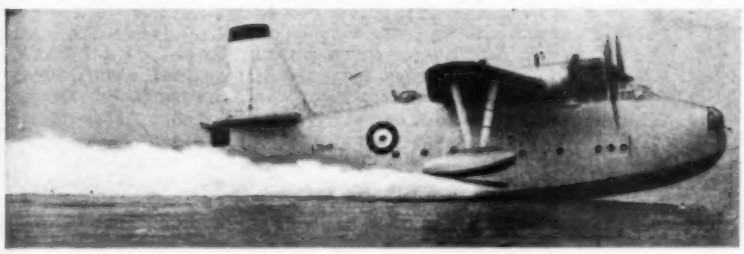
The spotter-reconnaissance machines carried on warships other than aircraft carriers are commonly floatplanes though our Supermarine Walrus is an amphibian flying boat. Such machines must have folding wings, and are, of course, specially stressed for catapulting. As they are usually taken aboard their parent ship by derrick provision must be made for hoisting gear. Being mounted on deck they may be subjected to the blast of guns. The Americans and Italians favour the central-float layout with auxiliary wing-tip floats, but Great Britain adheres to the small flying boat or twin-float seaplane.



A further selection of naval aircraft. At the top is the little Fairey Seafox (Napier Rapier VI) of the type which did so well in the River Plate battle. Below is the Supermarine Walrus with Bristol Pegasus, the first machine of its type to be catapulted. Then comes an American Grumman JF-1 "utility" deck-landing amphibian. Below this is a close-up of a Grumman single-seater Navy fighter showing the patent retractable undercarriage. The two-seater with land undercarriage is the Blackburn Roc turret fighter as used by the Fleet Air Arm.

SHORE-BASED MARINE AIRCRAFT

And Coast-Defence Landplanes



The Short Sunderland flying boat (above) has done magnificent work over the Atlantic since the beginning of the war. It has four Bristol Pegasus engines.

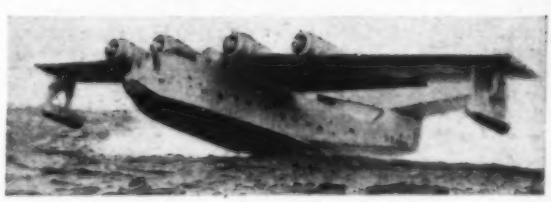
On the left is a Saro Lerwick (two Bristol Hercules), another standard type in the R.A.F.

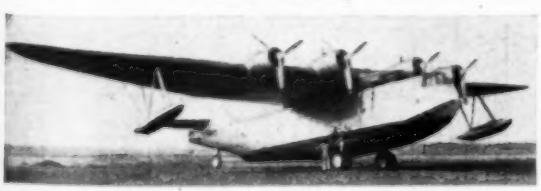
UNDER this heading may be grouped all aircraft which, though capable of operating far out to sea are based on shore. These include large flying boats and floatplanes (or amphibians) for bombing, torpedo-dropping, possibly mine-laying, reconnaissance, naval co-operation, patrol and convoy; landplanes for similar duties; and a few more specialised machines—floatplanes and landplanes—such as torpedo-bombers and dive-bombers. Fighters may be required to operate for a considerable distance out to sea, but these demand no special notice here as they will be standard types with flotation gear and perhaps extra tankage.

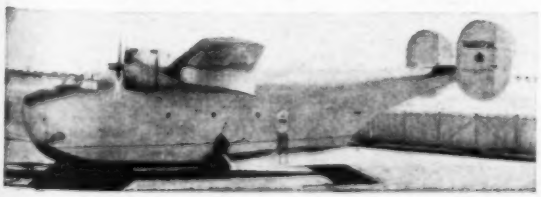
In constructional design and layout the large military flying boats are generally similar to corresponding commercial machines. They are extremely roomy and well-armed and no better example could be chosen for examination than the Short Sunderland, which is doing such valuable work on patrol and convoy duty over the Atlantic.

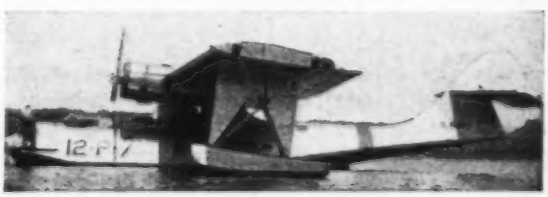
The hull of the Sunderland is divided into two decks, the upper accommodating two pilots side by side, a navigator, wireless operator and engineer.

Towards the rear of the upper deck, which extends to a point just aft of the main plane, is stowage for flares and maintenance cradles. The lower deck embodies the moor-

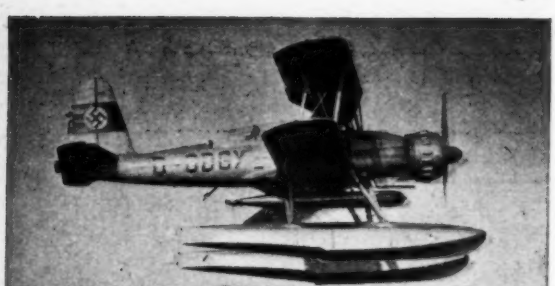








A selection of large marine aircraft. Immediately below are the Vought Sikorsky XPBS-1 and the new twin-engined Consolidated Model 31. Reading from top to bottom in the right-hand column are the diesel-engined Blohm and Voss Ha 138; the Consolidated XPB2Y-1; the Martin XPBM-1; and Consolidated PBY. An amphibian version of the last-named is now flying.



ing compartment, lavatory, officers' wardroom, galley and quarters for the crew. The wardroom and crew's quarters have bunks and folding tables. The upper deck is reached either by a stairway adjoining the lavatory or by a ladder.

SHORE-BASED MARINE AIRCRAFT (Continued)

On the left, from top to bottom, are the Arado Ar 95 (Germany); Latécoère 298 (France); Heinkel He 115 (Germany); and Fokker T.8-W (Holland).

Apart from the usual marine equipment (anchor, drogues, bollards, etc.), there is a fitter's work-bench with vice; flares, with launching chute; and provision for a camera. Other items of Service equipment include marine distress signals, smoke puffs, microphone and telephone system, two collapsible dinghies and awnings for use while at moorings in hot climates. The galley has a cooker, fresh-water tanks, paraffin tank, draining rack and an ice chest.

Apart from a heavy bomb load, accommodated in the hull, there are two Nash and Thompson power-driven gun turrets (bow and stern) and two midships gun mountings.

Great Britain and Japan are believed to be the only countries having four-engined military flying boats in service in appreciable quantities.

There is a greater variety of twin-engined types, one of the most modern being the Saunders-Roe Lerwick, which embodies several unorthodox design features. The wing-loading is obviously very high, and the machine is fitted with three power-driven gun turrets.

An even higher wing-loading may have been adopted for the new Consolidated 31, which has two Wright Duplex Cyclone engines rated at 2,000 h.p. each for take-off.

Flying boats do not normally operate at very great altitudes, and are accordingly fitted with medium-supercharged engines. When attacked by fighters they descend almost to sea level, thus preventing the fighters attacking from below or diving steeply from above. Nevertheless, in certain designs a gun position is let into the bottom of the hull.

Some of the newer designs have provision for mounting 20 mm. shell-guns for employment not only against attacking enemy aircraft but for firing on surface vessels.

It is in long-range marine aircraft that the diesel engine may be used to best advantage due to its economical cruising consumption over long distances. Three types of German flying boat have Junkers Jumo diesels.

Most countries have experimented with large multi-engined military floatplanes, and France, Italy and Germany use them to a considerable extent. These machines can be equipped as torpedo-carriers, the projectile being stowed internally. A disadvantage, however, is that due to their bulk they present an excellent target to anti-aircraft gunners while the pilot is aiming.

For general over-water duties the Royal Air Force has large numbers of landplanes (Anson and Hudson), which, apart from the duties for which they were originally adopted, have shown themselves capable of bringing down large enemy aircraft which they may chance to meet.

MARINE AIRCRAFT

Designation of Aircraft	Span	Wing Area	Wing Loading	Gross Weight	Disposable Load	Engine Type	Cooling	Rated Power	Max. Speed	At-tained at	Climb To	Climb In	Service Ceiling	Typical Armament	Progress
	ft. in.	sq. ft.	lb./sq. ft.	lb.	lb.			h.p.	m.p.h.	ft.	ft. M	min. M	ft.		
GREAT BRITAIN															
Short Sunderland	112 9½	1,487	20.0	44,600	17,410	Bristol Pegasus XXII ...	A	3,400	210	6,250	—	—	16,000	7 rcmg	IS
AMERICA															
Consolidated PBY ...	104 0	1,399.4	19.35	27,080	12,542	Wright Cyclone G103A ...	A	1,720	206	14,300	15,000	12.9	29,700	4 rcmg	IS
GERMANY															
Blohm and Voss Bv.138 ...	88 7	1,205	21.73	26,180	8,360	Junkers Jumo 205C ...	L	1,530	171	—	13,120	48	—	4 rcmg	?
Blohm and Voss Ha.140 ...	68 10	941.5	19.88	18,700	4,840	B.M.W. 132Dc	A	1,600	198	—	16,400	39	—	3 rcmg	?
Heinkel He.115	72 10	941.5	21.25	20,020	8,350	B.M.W. 132N	A	1,700	220	11,150	13,100	18	21,300	3 rcmg	IS
ITALY															
Cant Z.501	73 8	667.3	19.65	13,117	4,629	Isotta-Fraschini Asso XI R C15.	L	900	170	8,200	13,100	20	—	4 lbmg	IS
Cant Z.506B	86 8	940.3	28.6	26,895	8,818	Alfa 126 R.C.34	A	2,400	229	13,100	13,100	14	26,000	3 lbmg	IS
Torpedo-carrying Aircraft															
FRANCE															
Latécoère 298	49 5	334	28.5	9,546	3,657	Hispano-Suiza 12 Ycrs ...	L	860	186	6,500	—	—	19,680	2 rcmg	IS
ITALY															
Caproni Ca.312 I.S. ...	53 2	416.5	30.1	12,566	3,747	Piaggio P. XVI	A	1,260	236	13,100	13,100	16	16,400	3 rcmg	NP
HOLLAND															
Fokker T.8-W	65 7	559.7	24.6	14,550	4,574	Bristol Mercury XI ...	A	1,780	222	—	13,100	11.5	22,300	5 rcmg	IP

A—air cooled; AO—available to order; IP—in production; L—liquid cooled; lbmg—large-bore machine gun; NP—new prototype; OP—out of production; PO—prototype only; P and W—Pratt and Whitney; rcmg—rifle-calibre machine gun; sg—shell-gun.

TRAINERS

Elaborate Equipment of "Crew" Trainers : Biplanes and Monoplanes

MOST countries have their own ideas on the training of pilots and aircraft crews but modern instructional machines fall, nevertheless, into the following categories; primary or *ab initio* biplanes and monoplanes; single-seater aerobatic or fighter trainers; advanced two-seater single-engined trainers; and twin-engined machines which may be employed not only for flying instruction but for training in observation, gunnery, photography, bombing, etc.

Although there has been a marked influx of *ab initio* monoplanes into the Air Forces of the world, the biplane has by no means been entirely displaced for primary instruction. The argument that biplane trainers are being delivered for the sole reason that the availability of jigs permits rapid delivery is not entirely true.

The primary trainer is essentially a simple economical machine but its design requires very careful thought. It must be tractable and strong and yet not over-easy to fly. Attempts to adapt primary trainers for more advanced work have been made but not with entire satisfaction.

As explained last year, the R.A.F. ordered some prototype *ab initio* trainers which were considerably heavier than established machines and would carry more equipment, naturally requiring greater horse power. Such machines have not yet appeared in service; the standard R.A.F. machines for primary instruction (D.H. Tiger Moth and Miles Magister) having no more than 130 h.p. Germany, with her Bucker Jungman utilises even less power (80 h.p.) and apparently obtains good results.

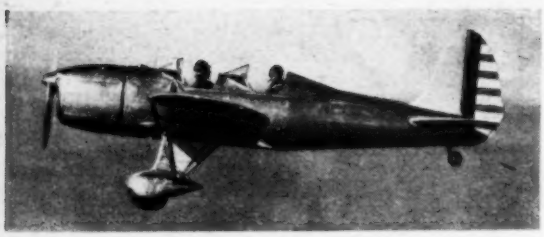
Single Seaters

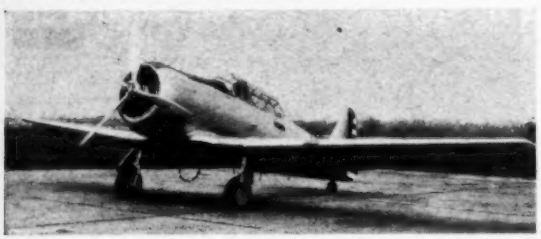
The specialised single-seater aerobatic or "fighter trainer" has never found favour in this country. Germany uses the little Bucker Jungmeister—probably the most manœuvrable machine in the world—as the second step from the primary two-seater, and the French Government has acquired a number of fighter trainer prototypes which are typically monoplanes of about 220 h.p. with a fairly high wing-loading and a speed of over 200 m.p.h. Should aircraft of this sort be considered necessary the Percival Mew Gull has many obvious merits.

Two-seaters of higher power (400-700 h.p.) are being used to accustom pupils to high speeds, the responsiveness which comes with reserve of power and the technical advances which are inseparable from high performance—variable-pitch airscrews, flaps, possibly slots and retractable undercarriage. This type is exemplified by the Miles Master, the North American series (e.g., Harvard) and the Curtiss-Wright Falcon. Provision is made not only for normal flying instruction but for instrument flying, gunnery and bombing. The Master is of special interest because it has a liquid-cooled engine of comparatively high power (Rolls-Royce Kestrel XXX) instead of the more common radial. This power plant is an example of how obsolescent Service type engines can be modified and adapted specially for training purposes.

As a large percentage of modern military aircraft are of multi-engine design the twin-engined trainer is coming more and more into prominence. There is no better example of the type than the Airspeed Oxford which, with two Siddeley Cheetah engines of 375 h.p., is capable of

Some British trainers. From top to bottom they are the De Havilland Tiger Moth and Miles Magister (*ab initio* types); the rather more powerful Henderson Trainer; the Reid and Sigrist twin-engined type; the Miles Master, an advanced single-engined machine; the twin-engined Airspeed Oxford and the Avro Anson.





TRAINERS (CONTINUED)

The Ryan PT-16 (left) is a primary trainer adopted by the U.S. Army. Below it are the fast Italian Nardi F.N.305 and, finally, the latest machine in the North American advanced trainer series. This is more recent than the R.A.F Havard.

192 m.p.h. Side-by-side dual controls are fitted and there is provision in the fuselage for standard wireless navigational, photographic and oxygen equipment. For training purposes the crew does not normally exceed three, though accommodation is provided for pilot, navigator or second pilot, bomb-aimer, wireless operator, rear gunner and camera-operator. For armament training a single gun is used for a manually operated turret and sixteen 18½-lb. practice smoke bombs are carried in standard electro-magnetic racks. In the R.A.F., the Avro Anson is used for similar duties.

Reid and Sigrist, Ltd., have developed a twin-engined trainer which is considerably different in character, being a smaller machine with two 205 h.p. Gipsy Six engines and having three tandem seats. The pilot's cockpit corresponds with the leading edge of the wing; the observer or instructor is behind him; and the rear gunner or radio operator is at the rear.

Below the middle seat is a prone bombing position. The R. and S. trainer has a top speed of 205 m.p.h. and is extremely manœuvrable. As a stepping stone between more orthodox trainers and twin-engined high-speed fighters and bombers, it has many points of merit.

MILITARY TRANSPORTS

IN the R.A.F. there exists a class of aircraft, best exemplified by the Bristol Bombay, known as "bomber transports." This type is capable of carrying a considerable number of fully armed and equipped troops, or alternatively, of transporting spare engines, stores, ammunition, etc.

Germany uses large numbers of the old Junkers Ju 52 bombers as transports and has adapted many of them for the dropping of parachutes following the Russian technique.

America does not normally arm her military transports, which are, in fact, modified commercial machines, but equips them expressly for the transport of personnel, equipment and stores.

The Bristol Bombay, although powerfully armed and capable of working as a bomber, was designed primarily to accommodate troops and to transport bulky loads.

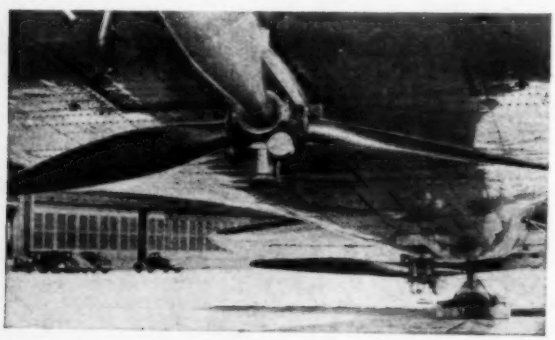
In the design of a large military transport the doors in the fuselage must be sufficiently large to permit the loading of large articles, and the cabin floor and roof may have to be specially strengthened. Complete airscrews present a particularly difficult problem, and may have to be stowed externally, just as on certain types of flying boat there is provision for carrying a torpedo on top of the hull.

The high-wing monoplane layout is probably the most suitable; not only does this facilitate loading but it is an advantage in hot countries where transports are used extensively for carrying troops.

For the transport of selected personnel and staff officers there is demand for fast, safe machines, a demand which is easily met by standard types of commercial aircraft. The De Havilland Flamingo is, perhaps, the most suitable of the larger machines, and has, in fact, been adopted by the R.A.F. Another useful type is the smaller twin-engined machine on the lines of the Lockheed Electra or Airspeed Envoy.

For economical liaison work the small two-, three- or four-seater "private-owner" aircraft are admirable. A particularly useful type is the Percival Vega Gull.

Slots and flaps might profitably be employed as the machines would be required to operate from confined spaces. There seems to be no reason why the light liaison machine should not be identical, except for equipment, with the small type of army co-operation aircraft.



Showing how a spare airscrew can be carried beneath the fuselage of a Douglas transport belonging to the U.S. Army Air Corps.

THE 1940 FLAMINGO

Hydromatic Airscrews : Perseus XVI Engines : Increased Pay Load

FROM the remarks made during Mr. A. S. Butler's speech at the annual general meeting recently, it was obvious that the De Havilland Aircraft Co., Ltd., does not intend to let its commercial business die during the war. Already the firm has translated its chairman's words into action by announcing an improved version of the Flamingo. It was always a very good aeroplane, and the new features will help it to keep its place in commercial aviation during the coming years. In spite of insistent calls upon their production in other directions, the works will make time to keep the D.H. flag flying in the commercial world. The importance of maintaining our exports has already been stated in *Flight*, and we need not stress it here.

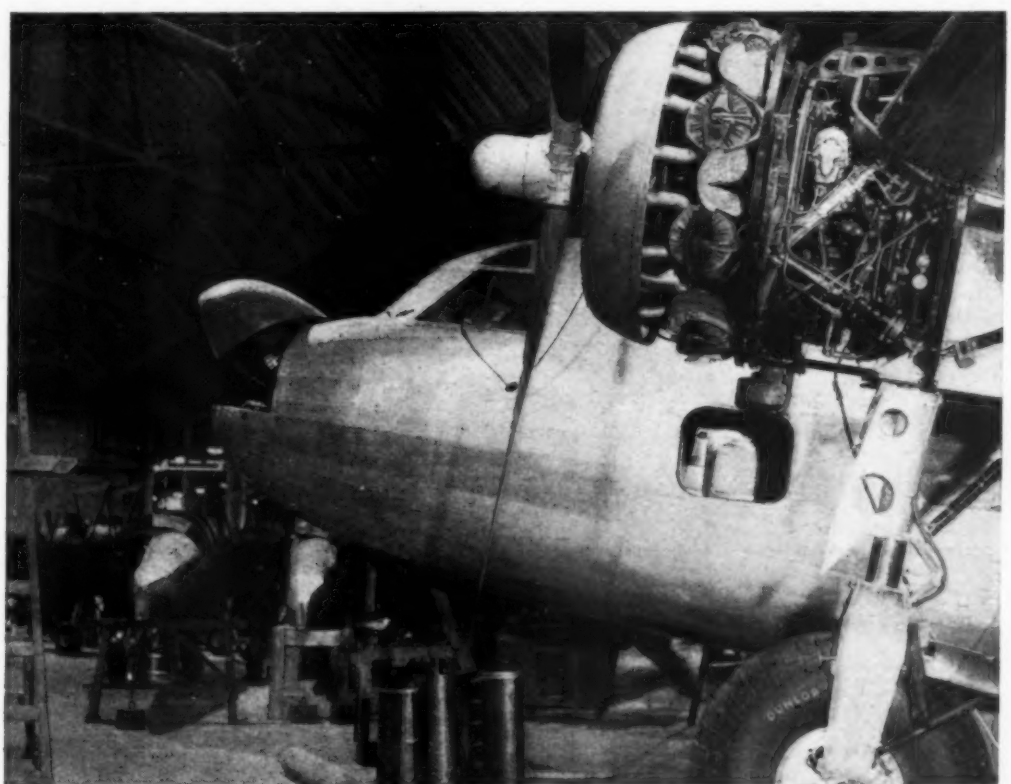
The 1940 model of the De Havilland Flamingo (DH 95) passenger liner has a later type Bristol sleeve-valve engine, the Perseus XVI, which has a greater power rating at altitude than the Perseus XIIc fitted to earlier models. Maximum power in level flight for 5 minutes is 905 h.p. at 6,500ft. for the XVI, compared with 815 h.p. at 6,000ft. for the earlier XIIc. This gives an improved performance in rate of climb, higher two-engine and single-engine ceilings, and quicker take-off at altitude.

The new Flamingo has De Havilland Hydromatic feathering airscrews, and though this involves an increase in airscrew weight of 100 lb., the better performance due to increased engine power has allowed the loaded weight to be increased by 600 lb., so giving an increase in disposable load of 500 lb. The loaded weight is now 17,600 lb. (7,990 kg.). Wing loading becomes 27.0 lb./sq. ft. (131,8 kg./sq. m.) and power loading 10.05 lb./h.p. (4,5 kg./Cv.) on take-off power.

The increase in disposable load allows the provision of more comprehensive equipment, such as automatic pilot and de-icing apparatus, without reduction of passenger accommodation. This increase is not at once evident in the new tare weight of 12,020 lb. (5,452 kg.) because of the inclusion of these and furnishing and equipment items additional to those given in the article on the Flamingo in our issue of February 16, 1939. The tare weight now includes the following:—

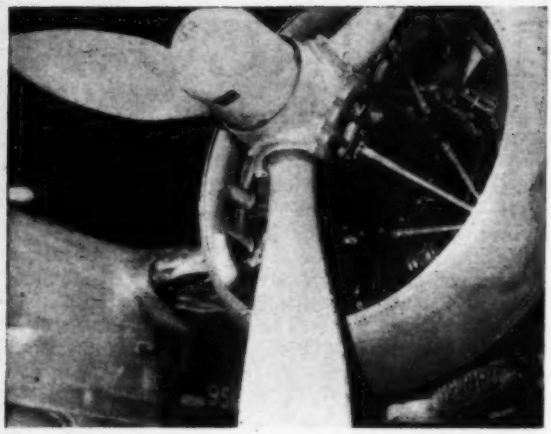
Full dual control, complete twelve-passenger cabin and toilet room furnishing, cabin ventilation, heating and lighting systems, Lux type engine fire extinguisher and hand extinguishers in cabin, 200 lb. (91 kg.), allowance for radio equipment with full D.F. apparatus, complete set of instruments, and Sperry automatic pilot, 100 lb. (45 kg.), provision for fitting blind approach radio receiver, forced landing flares, 50 lb. (23 kg.), complete hydraulic and electrical systems (including landing lights), Goodrich airscrew and airframe de-icing, 95 lb. (43 kg.), control locking gear, signal pistol and cartridges, 9.5 lb. (4,3 kg.), engine and airscrew covers, 15 lb. (6,8 kg.), glycol windscreen spray and Hydromatic airscrews.

Single-engine performance gives an absolute ceiling on continuous emergency power of 9,300ft. (2,836 m.)



"Flight" photograph.

An extra safety feature is introduced into the 1940 Flamingo by the fitting of more powerful Perseus XVI sleeve valve engines and Hydromatic airscrews. The new model is nearly ready at the De Havilland works.



"Flight" photograph.

The Hydromatic airscrew on one of the Perseus engines of the Flamingo.

and 8,200ft. (2,499 m.) for starboard and port engines respectively, the performance on each being slightly different. Rates of climb at sea level on take-off power are 230 and 210ft./min. (1,17 and 1,07 m./sec.) respectively.

The rate of climb at sea level on two engines at take-off power is impressive, being 1,470ft./min. 7,47 m./sec.); on climbing power it is 1,010ft./min. (5,13 m./sec.). Absolute ceiling on continuous emergency power is 22,200ft. (6,771 m.) and service ceiling 20,900ft. (6,374 m.).

Fuel tanks for 402 gals. (1,827 litres) are provided and an oil capacity of 24 gals. (109 litres). This gives a still air range of 1,210 miles at 65 per cent., and 1,345 at 50 per cent. of continuous emergency power.

Other technical data relating to the Flamingo are given below:—

Weights

With 500 miles range against a 40 m.p.h. head wind, cruising at 65% continuous emergency power

Tare weight	12,020 lb.	5,452 kg.
Crew, 2 at 170 lb., plus 1 at 140 lb.	480 lb.	222 kg.
Fuel, 212 gals.	1,590 lb.	722 kg.
Oil, 24 gals.	216 lb.	98 kg.
Buffet equipment	50 lb.	23 kg.
Payload	3,244 lb.	1,472 kg.
Total loaded weight	17,600 lb.	7,990 kg.

Engine Ratings (per engine)

	H.P.	Altitude	Cv.
Take-off power at S.L.	875	S.L.	887
Max. take-off power	930	5,750 ft.	943
Climbing power	745	6,500	755
Continuous emergency power (30 mins.)	805	6,000	816

Performance

	M.p.h.	Altitude	Km./hr.
Max. speed at max. power	239	6,500 ft.	384
Cruising speed at 65% continuous emergency power (523 h.p., 66.5 g.p.h. consumption)	200	10,000	322
Take-off run with flaps at sea level in 5 m.p.h. wind	—	312 yds.	285 m.
Height at 656 yds. from rest with flaps in 5 m.p.h. wind	—	145 ft.	44 m.
Landing run with flaps in 5 m.p.h. wind	—	325 yds.	297 m.
Take-off run at 5,000 ft. with flaps in 5 m.p.h. wind	—	340 yds.	311 m.

Holiday Air Travel

HAPPILY there are signs coming with the turn of the year and the longer days of increased traffic on the surviving internal routes. Air traffic figures for the services to and from Ireland, in the Western Scottish areas and to Paris all tend to show growth despite the war. This tendency is also showing in particular directions. With the opening of the holiday season at Easter, the Workers' Travel Association has announced plans to utilise air travel to Jersey and the Scillies. It is the first time that air travel to Jersey has been arranged by this organisation, and prices are now quoted to include accommodation, rail travel London-Shoreham and London-Penzance respectively, and thence by air.

Air Mail Summary

MAJOR TRYON'S answer to a question in the House of Commons recently gives a useful summary of the air mail services which are at present available by British and other airlines.

Daily services go to France, Belgium and Holland and letters for Denmark, Norway, Sweden, Finland, Latvia and the U.S.S.R. are carried onward from Holland. Air mail for other European countries only goes by air to Paris and thence by surface. The time for transmission to Paris (excluding collection, censorship and delivery) is up to 1 day, with 3 and 4 days for Stockholm, Moscow and Rome respectively.

On the Indian, Hong Kong and Australian routes there are two services each week with scheduled times of 6 days to India, 8 days to Malaya and Hong Kong, and 12 days to Australia. West and South Africa have one service weekly, taking 5 or 7 days to East Africa and 7 to West and South Africa.

Pan American run the Lisbon-New York route twice each week and transmission time might be as low as 3 or 4 days. But weather has put the average up to 14 lately. There is a French service weekly from Marseilles to South America, and London to Rio de Janeiro. Buenos Aires and Santiago under the best conditions should take 4, 5 and 6 days respectively. An alternative route to South America is from Lisbon to New York, thence south by the airlines in America. It was stated that air mail received priority of censorship.

New Airline Alma-Ata-Hami

REGULAR air communications have been opened between Alma-Ata (Kazakhstan) and Urumchi and Hami (Western China). The new air service, which is a weekly one in each direction, is being run by the Soviet-Chinese Aviation Company "Hamiata," formed by the Soviet Civil Aviation Fleet and the Ministry of Communications of the Chinese Republic.

These little-known places are situated in the heart of Asia. Alma-Ata is due south from Lake Balkash while Urumchi and Hami are west from Alma-Ata. The route mileage is very roughly 800.

"Golden Era" of D.D.L

THE Danish airline company continues to make a thorough job of internal aviation. On February 21 it set up a new record by carrying 513 passengers, 29 tons of mail and 11 tons of air freight on the two services from Copenhagen to Fünen and Northern Jutland. The company practically withdrew from the international business and devoted all its flying material to the task of making up for the shortcomings of the railways and shipping. The company's two new Condors are scurrying as fast as they can between Copenhagen and Aalborg, making seven round trips a day each. In addition, a distress call has been received from the county council of Bornholm, asking for the immediate opening of a special service from Copenhagen to Rönne, since the shipping companies at the end of a long fight against ice and minefields have capitulated.

The "foreign business" at Kastrup is largely being handled by the Swedes, Germans and Dutch, and all machines are booked full. Passenger traffic in and out of Kastrup runs into some 700 persons a day, in addition to heavy consignments of air mail and air freight.

Topics of the Day

COLD COMFORT

A Mild Diatribe Against Designers for Their Failure to Recognise the Existence of a Pilot

LONG ago, in the piping (and exciting) days of peace I used to grumble occasionally about the way in which water came into cabin machines and about the very wide and dangerous divergence of fields of view. Since those days I have been more or less exclusively occupied in flying military aeroplanes and have seen no reason to change my opinions.

Designers do *not* recognise the existence of a pilot—at least, not in nine cases out of ten. In fighting aeroplanes, of course, the view in homicidal directions is excellent, and they have the not-to-be-exaggerated boon of an adjustable seat, though in this the advantages are sometimes limited by the existence of a sliding roof. After an initial and painful experiment one learns not to pull the lid forward after the take-off when the seat adjustment is in the top notch.

But nobody yet appears to have solved the problem of providing adequate bad-weather view. With one or two types one might just as well settle down to fly on instruments as soon as it starts to rain really hard. And with nearly all types the interior becomes steadily wetter and wetter as the flight continues. If the rain does not actually spurt or dribble through the fixed parts of the screen, it certainly comes through all manner of chinks in any movable sections on screen or roof.

Steadily worsening climatic conditions inside an aeroplane can be tolerated with patience during short flights, but become extremely irritating after an hour or two, and the problem is worth solution from the psychological point of view. A pilot who has been rained on from varying points during a long trip is not likely to have quite the inner fighting strength of one who has sat in comfort approaching luxury. Furthermore, a well-directed jet of water in the eye does not improve a pilot's aim when looking down the sights.

View v. Comfort

Which brings me back to the question of view as opposed to that of comfort. In peace-time it is nice but not essential to be able to see ahead in rain both while flying and while coming in to land. In wartime it is absolutely necessary to see as much and through as wide a range as possible in all conditions.

Since no form of windscreen wiper appears yet to be a practical possibility, the majority of machines are fitted with "bad-weather" windows. Some are marvellously good, letting in not a drop of rain nor a breath of wind, and one, at least, provides a sufficient range of view for offensive purposes. Others are indifferent and should only be opened in cases of dire necessity when it is considered that double pneumonia is preferable to sudden death. Some are complicated in the Heath Robinson manner. Others are so simple that the Air Ministry is only with difficulty persuaded to accept them as practicable.

A Question of Pressure

Speaking without my aerodynamic textbooks, it would seem that the really successful examples depend for their virtues on the variation of pressure inside and outside. In other words, the pressure immediately in front of the screen is actually less than that inside the cockpit. So much so that their opening causes dead rats, dust, and packets of sandwiches to fly up the fuselage and into the driver's lap. That is a small discomfort easily balanced by the advantages.

This being the case, surely it should be possible to design a nose and screen layout—at least on twin-engined machines where there is no slipstream effect—so that either the rain does not reach the screen or, when it does, will move across it in clear sheets rather than in complicated cascades.

I am probably talking through my hat, but it does seem to me that a little more work might be expended on the different aspects of this problem. It is encouraging to the pilot to find that he can see forward. The fact gives him confidence in the designer of the machine and in his ability to cope with rather revolting weather when there is not a great deal of room between the hard, uncompromising earth and the cloud base.

While I am being impolite about things in general, I may as well say that the control layout of some of our aeroplanes can only be described as an amateurish muddle. The designers concerned might care to look inside any modern American aeroplane. It is just as if the machines have been fitted with an A.S.I. and a throttle, after which various people have come along to demand the fitting of such and such a control while assembly is in progress. Presumably it is known beforehand that flaps, v.p. airscrews and so forth are to be fitted. Or is it that nobody is sure until the aircraft is almost complete; or, perhaps, that nobody really cares—the pilot can sort it all out afterwards.

INDICATOR.

Black Days at Brough

IT is with extreme regret that we have to record the death recently, in air accidents, of three members of the staff of Blackburn Aircraft, Ltd. Mr. B. R. Rolfe, the firm's assistant test pilot, and Mr. J. B. E. Johnson, installation engineer, were the victims of one accident, and Mr. G. C. F. Ely of another.

Mr. Ely began his aeronautical career as an apprentice at Vickers. In 1917 he joined the R.F.C., and served during the war. As soon as he was demobilised he joined the Blackburn firm, where he remained until he joined the R.A.F. on the outbreak of war. Mr. Ely was for many years publicity manager and more recently he was put in charge of the Blackburn service department as well.

Mr. Rolfe joined Blackburns in 1929 and was sent to Greece in connection with the factory which Blackburns established there for the Greek Government. He returned from Greece in 1937, and only a few days ago information was received that he had been awarded a Greek decoration for his good work.

Mr. Johnson came to Blackburns a little more than a year ago. We believe he came from the Royal Aircraft Establishment, Farnborough.

To the relatives of the three, and to the Blackburn company, we extend our heartfelt sympathy.

"Enemy Aircraft" at Edinburgh

ON March 19 an exhibition of aircraft models, photographs and sketches is being held at R. W. Forsyth's men's shop in Princes Street, Edinburgh. This exhibition for which Mr J. H. Stroud is responsible, consists of a good collection of accurate scale models of British and German types and many photographs, colour drawings and silhouettes.

A feature of the show is the model of the Keil raid, together with one of the raid on the Firth of Forth and another of the Balloon Barrage.

This is one of a series of exhibitions, the first of which was recently held in London, to be staged in various parts of the country to give the public a chance to distinguish between British and German aircraft.

WAR in the AIR

Machines of the Royal Air Force Go Farther Afield : Fighter Squadron Liable for Salvage Charges

ON Monday, February 26, The King and Queen paid a visit to Scotland. After inspecting dockyard workers and some naval units, the King drove to a naval air station, where men of the Fleet Air Arm are under instruction. He went on to a fighter station of the R.A.F. and decorated Sqn. Ldr. A. D. Farquhar of the Auxiliary Air Force with the Distinguished Flying Cross.

The Air Ministry's announcement of the award said:—"During February, 1940, this officer engaged an enemy aircraft while on patrol. Though he expended only a small amount of ammunition, the accuracy of his shooting appears to have put both engines of the enemy aircraft out of action and it affected a forced landing. Sqn. Ldr. Farquhar also very actively engaged enemy aircraft in October, 1939, and has led his squadron with magnificent dash and courage on several occasions."

During the first raid on the Firth of Forth on October 16, Sqn. Ldr. Farquhar chased one of the raiders over the roofs of Edinburgh. He was also leading his squadron when they shot down a Heinkel on the Lammermuir hills near Dalkeith on October 28. He was also concerned in bringing down another Heinkel, the one which crashed near St. Abb's Head; in fact, it was he who chased the Heinkel down and landed near it, but not in time to prevent the Germans from setting their machine on fire.

There seems no end to the initiative of the R.A.F. in spreading its wings over Europe. A visit to Berlin is now almost an ordinary event, but Prague and Vienna caught the imagination as long daring flights, great undertakings in themselves, and tokens to two independent countries which have been overwhelmed by the Nazi bullies that they have friends who do not fear the Gestapo and who mean to end the reign of terror in Europe.

But what of martyred Poland? She is our actual Ally in this war, and her sufferings have been at least no less than those of Austria and Czechoslovakia. We have not forgotten Poland. So on Thursday, March 7, the R.A.F. set out and paid a visit to Poland. It was a long flight, perhaps some 1,400 miles there and back, and it entailed flying many miles over Germany—not that that presents any terrors to our air crews. The visit must have come as a surprise to conqueror and conquered in Poland, and hapless folk on the ground, groaning over the fall of their country, and miserably suffering the tyranny of the Germans, must have felt their hearts uplifted when they heard the sound of the engines in the night, and afterwards learnt that their visitors had been British.

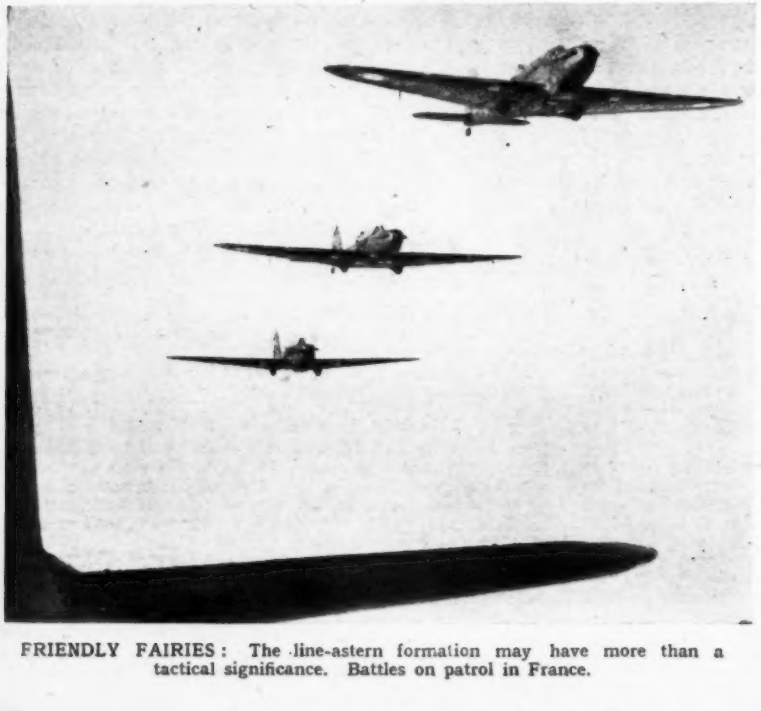
Misunderstood Intentions

AN 8,000-ton Dutch vessel, the *Stadshiedam*, was saved from destruction by mines on Tuesday (March 5) in the North Sea. An aircraft of the R.A.F. Coastal Command leaving on a long patrol sighted drifting mines and reported their position by wireless. Another Coastal Command aircraft was sent out to keep watch on the danger area. A minute or two after locating the mines the pilot observed the *Stadshiedam* standing into danger. The mines lay directly in her path. Flying over the Dutch ship, the pilot flashed a warning by lamp and told her to heave to or alter course at once.

Again and again he went round the vessel in tight circles repeating the warning and orders. The *Stadshiedam* paid no heed and continued on the same course. Obviously the lamp signals had not been understood. Only a short distance now separated the ship from the mines. In the pilot's phrase, "the position was becoming desperate." He next fired a number of coloured lights into the sea immediately ahead of the *Stadshiedam*, hoping that by this method the crew would realise their imminent peril. Still the vessel did not change course.

When the *Stadshiedam* was quite close to one of the mines the aircraft pilot took other measures. From close quarters he opened fire with his front gun across her bows. These tactics were successful. At once the *Stadshiedam* swung hard to port away from the danger immediately confronting her. But the Dutch crew remained unaware of their narrow escape until a British naval vessel was called and destroyed the mines.

In a recent action in France two R.A.F. fighters sighted a formation of seven Heinkels and later engaged six Messerschmitts. Immediately on sighting the Heinkels our aircraft gave chase but the enemy, avoiding an engagement, sought the protection of their own lines and were pursued by our fighters over German territory. Before they could engage the Heinkels more closely the British patrol was attacked by the six Messerchmitts. The pilot of our leading fighter immediately engaged and shot down a Messerchmitt in flames. He in turn was attacked by a second Messerschmitt and a part of his wing was shot away by cannon fire and his engine was hit and partially disabled. As he lost speed the attacking Messerschmitt over-shot him. Handicapped though he was, our pilot,



FRIENDLY FAIRIES: The line-astern formation may have more than a tactical significance. Battles on patrol in France.

having the enemy at a disadvantage, pressed home his attack. The Messerschmitt was seen to go down apparently out of control and is believed to have been severely damaged. Our second fighter was forced to break off the engagement owing to a damaged airscrew. Nevertheless, both he and the leader of the patrol, in spite of the damage they had sustained, landed safely.

War has its humours as well as its horrors, and Red Tape can wrap itself round the pilot of a fighter if he claims the spoils which have fallen to his guns. Members of the Fighter Command squadron which shot down a German Heinkel bomber in Cresswell Bay, Northumberland, on February 3, have been told that they are liable in law to pay salvage and other charges on the wreckage which was washed ashore from the bomber.

Two More Heinkels

TWO Heinkels were shot down over the North Sea on Thursday, March 7, one by Spitfires of the Fighter Command and the other by a machine of the Coastal Command. Fighter aircraft shot down another on Friday, the 8th.

The Spitfires which gained the success on the Thursday were a patrol of four, the pilots including one New Zealander, two Scots, and a sergeant from Sussex. The Heinkel was first seen flying east at a height of some 27,000ft. off the coast of Aberdeenshire. A.A. guns opened fire while the Spitfires climbed to attack. The combat was brief, and one of the Heinkel's engines was straightway put out of action. The German pilot turned and tried to reach the land, but could not do so. The machine came down in the sea, and the Spitfire pilots saw a rubber boat launched. They reported this to the shore, and a R.A.F. seaplane tender put out to rescue the survivors. So hurriedly did it start that there was no time to lay in extra provisions, but there was a bottle of rum on board. The boat put off at 3 p.m., and the journey to where the Heinkel had been shot down took four hours. A Coastal aircraft was waiting overhead to guide the rescue boat, and it fired coloured lights to show the way to the boat.

Only one man was found in the rubber dinghy, the N.C.O. pilot, and he had been wounded in the shoulder and legs. Of the other three, one had been killed, and the other two so severely wounded that they were drowned in trying to get into the dinghy. The pilot was taken on board, but while a tot of rum was being poured out for him, the pitching of the launch in the swell caused the bottle to fall and be broken. The German, who spoke good English, told the rescuers that in the rubber dinghy they would find a bottle of whisky, a bottle of soda water, and chocolates and biscuits. The man's wounds were dressed and he was given dry clothes. A few minutes later he was fast asleep. Meantime the weather had got worse, and the launch was 60 miles from the shore. There was danger of running on a sand bank, and so the launch had to lay off at sea the whole night—a night of rain and intense cold. At 9 a.m. next morning they reached land, and the wounded prisoner was sent to hospital.

On the same day the Coastal Command was quite busy. One of its machines sighted a Heinkel 115 twin-float seaplane about a mile ahead. The British aircraft pursued, overtook it and attacked from dead astern. Steady fire was maintained during the approach. At 150 yards it was apparent that bursts were entering the enemy's fuselage. At 50 yards range the attack was pressed home. There was evidence now that the German rear gunner had either been disabled or killed. Until then, he had fought back vigorously. One of the British crew then signalled that his gun had jammed, and the aircraft was flown into cloud to allow the fault to be remedied. With all his guns again serviceable, the pilot emerged and saw his opponent below him. He dived to renew the combat at close range and the damaged Heinkel was driven to find refuge in cloud.

The British aircraft, which was unscathed in the action, searched for its adversary unavailingly, and then proceeded on its patrol. Soon afterwards, the pilot saw three German patrol vessels, which he immediately attacked with bombs. With a storm of anti-aircraft fire around him, he could only observe one of the bomb-bursts—hardly the distance of a cricket pitch, as he described it, from one of the ships.

DROPPING THE LEAFLETS: "I can say that there is a considerable body of evidence that these leaflets are read by members of the German public who are glad to read them, notwithstanding the severe penalties with which they are threatened." (Sir Kingsley Wood.)

Having practically no machine-gun ammunition left, and having expended all his bombs, the pilot was obliged to break off the action. Thereafter he went on with his reconnaissance.

Another pilot of the same squadron on a different patrol saw a Heinkel floatplane almost at sea level. He dived from 2,000ft. and attacked it on the starboard quarter with his machine-guns. He then climbed back to his original height and dived again with his front gun in action. The German rear gun, which had fired steadily without result during both attacks, was silenced. The enemy aircraft thereupon made for dense clouds through which it was chased for twenty minutes. During the chase it was seen on four occasions in the clouds, and each time bursts of fire were sent into it.

Bomber Command Busy

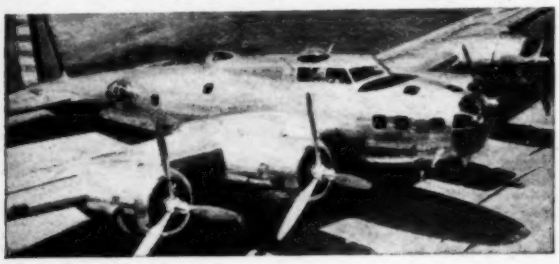
THE Bomber Command had also been industrious in the early hours of that busy Thursday. It sent aircraft over most of the principal cities and sea-ports in N.W. Germany, including Bremen, Hanover, Hamburg, Wilhelmshaven and Cuxhaven, while other aircraft maintained the R.A.F.'s customary "security patrol" over the island bases of German mine-laying seaplanes.

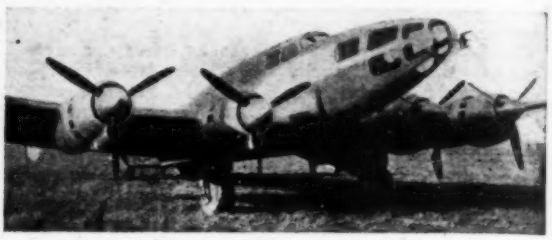
Intensive searchlight activity marked the passage of the reconnaissance aircraft over Germany. Beams of a bluish hue were most frequently encountered, and on two occasions our aircraft were held for nearly half a minute in the beams of a number of converged lights. Near Cuxhaven a battery of 20 to 30 searchlights came into action on the approach of our aircraft, but was quickly evaded.

Over Bremen, anti-aircraft guns opened heavy fire. Two aircraft, flying with their navigation lights on at a height of 10,000ft., were also seen by the crew of one British bomber when over Heligoland Bight, but there was no attempt to attack.

All our bombers returned safely to their bases, having covered in the aggregate a total of over 10,000 miles in the course of their night's reconnaissances.

BOMBERS (CONTINUED)





The nose of the new Boeing B-17-B (B.299Y) is shown on the left. The right-hand view shows the forward part of the Bloch 135 which, although it has four engines, is a considerably smaller machine.

present types of turret there is full equipment for heating devices, intercommunication 'phones, gun heating, oxygen apparatus and lighting for a reflector sight.

Few shell-guns have yet been installed on bombers, though some of the new French machines have a 20mm. gun on a restricted manually operated mounting on top of the fuselages.

Up to the present no bombers have displayed anything very startling in the matter of power-plant installations. The engines themselves are supercharged to as great a height as possible and two-speed blowers are now common. In the comparatively large bombers of the type being considered the mounting of engines in the fuselage may be extremely difficult due to military considerations, though engines buried in the wings seem a logical development in connection with an appropriate shaft drive. Radials of 2,000 h.p. (take-off rating) are now available and before long bombers mounting two liquid-cooled engines of H or X formation may be appearing. The design of one French bomber allows for the wing installation of two pairs of tandem-mounted 12-cylinder liquid-cooled B engines driving co-axial counter-rotating airscrews.

Protection

Fuel tanks of the self-sealing variety are becoming increasingly necessary and provision is being made in the design of modern bombers for a comprehensive system of armour-plating at vulnerable points.

Finally we have to consider the very largest type of bomber—typically of four-engined layout.

These giant machines are frequently condemned out of hand for no other reason than that they are big and consequently present good targets. The same, however, might be argued of our new battleships, though admittedly the offensive armament of a battleship is at the same time defensive.

The air staffs who are sanctioning, and even encouraging, the development of very large bombers, must be credited with sufficient common sense not to visualise the indiscriminate employment of such machines. Obviously they would be utilised only for special missions.

Technically, such machines will probably develop along the lines already suggested for bombers of intermediate size. Full use will be made of the most modern turreted armament though, curiously enough, the Boeing B-17 series employed as standard equipment in the U.S. Army Air Corps are armed with large-bore machine guns on manually operated mountings.

There is a particularly interesting armament installation on a new Italian Piaggio four-engined bomber. Two pairs of rearward firing Breda S.A.F.A.T. heavy machine guns are mounted on the wings, one pair in each outboard engine nacelle. The lines of fire converge at a point behind the tail, and the guns are fired by a gunner housed in an armed sighting cupola in the fuselage.

Speed

It is often inferred that a large bomber is a slow bomber, but this is by no means the case. The 37,000 lb. Boeing B-299Y, similar to the B-17-B as used by the U.S. Army Air Corps, is claimed to have a top speed of 268.5 m.p.h. at 14,000ft. Two French Bloch bombers are reputed to have top speeds in the neighbourhood of 300 m.p.h. For a range of 4,490 miles the larger of these—the 42,000 lb. 162-B5—can carry any of the alternative loads: 192 bombs of 22 lb.; 32 bombs of 110 lb.; 12 bombs of 220 lb.; eight of 440 lb.; or three of 1,100 lb. If the range is reduced to 870 miles, any of the following loads can be accommodated: 256 bombs of 22 lb.; 64 of 110 lb.; 24 of 220 lb.; 16 of 440 lb., or four of 1,100 lb. The machine is armed with two Hispano high-velocity 20mm. shell-guns with three 60-round drums apiece and two rifle-bore machine guns with 800 rounds each.

Unfortunately no reference may be made to any British four-engined bomber which may exist, but as an indication of what might be accomplished we may refer to the estimated figures for one verson of the Short 14/38 transport machine. Fitted with four Bristol Hercules sleeve-valve engines with turbo superchargers, the machine, flying at a weight of 71,000 lb., would cruise at 275 m.p.h. at 25,000ft. and have a range of 3,000 miles against a 30 m.p.h. head wind, carrying a load (including crew) of 8,800 lb.

FOUR-ENGINED BOMBERS

Designation of Aircraft	Span	Wing Area	Wing Loading	Gross Weight	Disposable Load	Engine Type	Cooling	Rated Power	Max. Speed	Attained at	Climb To	Climb In	Service Ceiling	Typical Armament	Progress
	ft. in.	sq. ft.	lb./sq. ft.	lb.	lb.			h.p.	m.p.h.	ft.	ft.	min.	ft.		
FRANCE															
Bloch 135 B4 ...	69 9	652	33.5	21,903	12,850	Gnôme-Rhône 14M ...	A	2,840	326	16,400	—	—	32,000	1 sg 2 rcmg	NP
Bloch 162-B.5	92 2	1,173	35.8	42,000	18,800	Hispano-Suiza 14Aa ...	A	4,480	295	16,400	16,400	18.1	29,500	2 sg 2 rcmg	NP
AMERICA															
Boeing B-299Y	103 9	1,417	26.1	37,000	10,857	Wright Cyclone G205A ...	A	3,600	268	14,000	14,000	8.1	29,300	5 rcmg	IS

A—air cooled; AO—available to order; IP—in production; L—liquid cooled; lbmg—large-bore machine gun; NP—new prototype; OP—out of production; PO—prototype only P and W—Pratt and Whitney; rcmg—rifle-calibre machine gun; sg—shell-gun.

THE AIR ESTIMATES

Token Votes Represent "By Far the Greatest Effort and Expenditure Ever Made by this Country"

THE Air Estimates for 1940 were introduced last Thursday, March 7, by the Secretary of State for Air, Sir Kingsley Wood, who said that for reasons of security the amount of our Service Estimates were not now disclosed, this being a time of war, but he was able to say that the Air Estimates of this year were of unprecedented character, and involved by far the greatest effort and expenditure ever made by this country in any year in relation to our air defences.

Although the Estimates were presented as token votes only, the paramount need for the strictest economy had been, and would continue to be, impressed on all concerned, both at the Air Ministry and throughout the Commands of the Royal Air Force. The Select Committee on National Expenditure, and, in particular, the Air Services Sub-Committee, could count on the Ministry's full co-operation.

The Estimates represented only in part the further action that we were taking and proposed to take in conjunction with the Empire overseas and with our Allies. Our expenditure and efforts could not be limited to this year, but they must be continued and intensified until we had achieved our fixed resolve—the establishment of mastery in the air.

Our pilots and our aircraft had already given a great account of themselves on numerous occasions in combat with the enemy. The aircraft of the Bomber Command and of the British Air Forces in France had carried out by night and day over 1,000 sorties well into German territory, while our fighters had taken off more than 2,000 times for patrol, pursuit, and combat.

The rôle of the Fighter Command had not been confined to the defence of Great Britain against attack from the air—it had extended to the coastal waters and had included the protection of convoys, fishing fleets, and neutral shipping near our coasts. Our fighters had amply proved their worth. Without a single loss on our side they had brought down some 40 German aircraft round our coasts, and we knew that many more of the enemy had been forced down in neutral territory, or in the sea, on their return flights.

Units of the Coastal Command had now flown more than 5,000,000 miles on reconnaisance or convoy duty. Since the outbreak of war they had sighted submarines on more than 100 occasions and had delivered more than 60 attacks. More than 700 convoys had been successfully escorted by aircraft of the command.

It had been over the North Sea and in hourly co-operation with the Royal Navy that the Royal Air Force had up to the present been mainly engaged.

Co-ordination

During the last two years, machinery had been built up for the closest co-ordination of Naval and Air operations. The Naval Commanders-in-Chief of the various Naval Areas and the Air Officers Commanding the Groups of the Coastal Command shared the same headquarters, and their responsibilities extended over the same areas. The closest liaison also existed between the Admiralty and the Coastal Command and with the Commanders-in-Chief of the Bomber and Fighter Commands. It was only a matter of seconds to put the First Sea Lord or the Naval Staff into direct touch with Commanders-in-Chief.

The closest connection between the two Services was also ensured by the special appointment of an Air Marshal and of an Admiral, whose task it was constantly to review together the operational situation in the North Sea and round our coasts, and to advise their respective Chiefs of Staff.

Co-operation with France was also of the most intimate character. In staff matters there was the closest contact. They had a comprehensive scheme for pooling information.

When he introduced the Air Estimates for 1939 he told the House that as a result of their recruiting efforts the total strength of the Royal Air Force was approaching 100,000. To-day the strength of one Royal Air Force Command alone had nearly reached that figure.

The quality of recruits had been and continued to be of the highest, and the Commander-in-Chief of the Training Command had told him that he had never known the quality of young men to be higher. Great as was the training organisation that had been built up in peacetime, it had not been possible to absorb at once the many thousands of applicants for Air Force service, and they had devised a scheme of "deferred service" under which the men accepted retained their civil occupations and so formed a pool on which they could draw.

At the outbreak of war they had in the Royal Air Force Volunteer Reserve a large reserve of trained and partly trained pilots carrying out training at a number of centres all over the country, and it had always been accepted that many of them would require further training after the outbreak of war. Some were, of course, able to proceed at once to advanced training and were now serving in the line; others had been given courses as instructors.

Of the remainder, over 60 per cent. had passed on to flying training. All would come in through the ranks. Every man in the Service, whatever his rank or trade, would, if he had the necessary personality and ability, have the chance of being recommended for a commission.

They were so organising their technical training that the man who was unskilled on entry would have the opportunity of learning a skilled trade, and the semi-skilled man would have the chance of becoming skilled. At this moment more than twenty schools were in operation, and others were being rapidly provided. In that way he hoped they would be able to reduce to a minimum their demands on industry.

Training

They were also engaged in building up a great flying training organisation overseas, and when in full operation the schools in Canada, Australia, and New Zealand under the Empire training scheme would produce no fewer than 20,000 pilots and 30,000 air crews every year. In addition, the Government of the Union of South Africa had most helpfully offered to train pilots, and there would also be schools in Rhodesia and in Kenya, and with the ready agreement of the French authorities they were establishing a number of flying training schools on French territory.

Within a few weeks of the outbreak of war they had passed the peak figure of labour employed on aircraft production which was obtained in 1918, but there was an enormous programme required and an even greater effort ahead. The country owed much to the hundreds of thousands of men and women in factories who were making a great contribution to their air defences.

In the case of materials, too, they had had to build up their supplies on a rapidly increasing scale. Before the war the Air Ministry had taken steps to extend the supply of the virgin aluminium and the special steels required for the air programme which they needed. Their own special problem was in the field of light alloys. It had been a case of creating and building up an industry for which there was only an extremely small commercial demand. Not so very long ago the total output of these light fabricated materials was a matter of a few thousand tons a year, but that had already been multiplied many times over. New factories had been built and existing factories extended, and every month new plant was coming into operation. Future production had been planned on a scale which should enable them to attain their objective with something in hand.

The plans they had made for production in the Dominions were beginning to bear fruit, and the first aircraft manufactured in Canada had already flown. Large additional orders had also recently been placed both in Canada and in the United States. The progress made in production to meet the needs of the Royal Air Force gave them cause for confidence.

Civil Aviation

First things must come first, and he was afraid, much as they would wish it otherwise, that the progress of civil aviation must inevitably be retarded. In spite of the exigencies of war, the Empire services of Imperial Airways had been carried on without interruption. In conjunction with the Australian and New Zealand Governments they had decided to link up New Zealand with the Empire air routes, and to start in April a weekly service across the Tasman Sea. The North Atlantic programme last year was completed without a hitch, but the resumption of this service must depend on the inexorable needs of the military situation. In Europe we had our regular services to France and Scandinavia, and it was hoped that the difficulties which had so far prevented a regular service to Lisbon would shortly be overcome.

To safeguard the position of civil aviation after the war,

he proposed to take two important steps: First to set up a strong Civil Aviation Advisory Committee to keep under review the position of civil aviation in the light of the present situation and to plan for the future; and, secondly, that this committee should have associated with it a small body of experts whose task it would be to keep in close touch with all phases of technical development in the field of civil aviation abroad. Thus the aircraft industry of this country would be enabled to keep abreast of technical improvements on the civil side and be ready when peace returned, or sooner if circumstances permitted, to devote its skill and its strength to the development and production of civil aircraft.

The British Overseas Airways Corporation had been established, though with reduced membership. It had adopted and ratified the provisional contracts for the acquisition of Imperial Airways and British Airways and a date would be fixed in the near future as the "appointed day" on which these undertakings would be transferred. He had been fortunate enough to secure the services of Mr. Clive Pearson as Chairman of the Corporation.

Production

Since the Air Estimates were last presented production for the Royal Air Force had been greatly increased. The numerical output had been doubled, but the effective increase in output had been even greater. To assess the true measure of advance account must be taken not only of numbers, but of the quality and performance of the aircraft passing into service. Each new type involved an increase in the number of man hours of construction—the Spitfire, for example, represented double the number of man hours spent on the Gladiator, and the same was true of the Lysander compared with the Hector. But these increases in man hours were far outweighed by the great advantages achieved in operational efficiency—in range, speed, bomb load, armament, and in the aggregate of all these factors. He would sooner have 100 Wellingtons or 100 Spitfires or Hurricanes than a much larger number of their German counterparts.

In the last six months the output of the single-seater fighter types—the Spitfire and the Hurricane—had doubled; and the output of the larger bomber types which involved a far greater number of man hours had been increased over the same period by more than 50 per cent.

Good progress had also been made in the output of engines, and the other day the output of a new type of engine reached and passed at one factory the figure of 100 a week. Moreover, it was possible by the embodiment of fresh devices and modification to go on improving our engines throughout their life in the Service.

A substantial measure of rearming had been carried out in the Service. Not only had squadrons been rearmed with more powerful types, but the types themselves had been continuously improved in armament and in performance. Thus the long-nosed Blenheims had not only far better navigational facilities than the earlier model, but something like a 50 per cent. increase in range. The top speed of the Spitfire had been further increased by 10 per cent. as a result of various developments subsequent to its introduction into the Service.

Taking into account the progress that had been made in the formation of new squadrons, in rearming, and in the building up of reserves, it could safely be said that the fighting strength of the Royal Air Force had been increased by at least 100 per cent. during the last twelve months. In addition, we had been able to give substantial help to our friends abroad.

During the same period Germany had no doubt also been expanding and improving her Air Force, but she had not been without her difficulties and many of her aircraft types must have proved disappointing in the light of operational experience. He therefore took the view with some confidence that even on a numerical basis the output of aircraft now accruing to us and to France was to-day in excess of that of Germany—and there are other factors besides numbers.

But Germany had undoubtedly a strong and powerful Air Force, and if enemy attacks come we must certainly not assume that they could be beaten off without casualties and damage. No air defence organisation could ever be an impenetrable barrier. If and when serious attacks were made on this country considerable damage might be caused, but we need have no doubt that our people would endure with the same high courage as other peoples had recently shown. Moreover, we could be sure that the powerful and efficient air defence organisation which we had built up would take a heavy toll of the enemy and that our bomber force for their part would be both ready and able to hit hard, hit often, and to keep on hitting.

Pamphlets

After debate, Sir K. Wood said the opinion had been expressed that flights over Germany were futile. It was not generally realised what the objects of these flights were. One of the principal reasons was to obtain information exceedingly valuable to us. It would not be wise for him to discuss in detail what that meant. There was evidence that these flights had had effect both on the production and the moral of Germany. There was also considerable evidence that the leaflets dropped over Germany were read by a very large number of people, notwithstanding the severe penalties with which they were threatened.

With regard to the criticisms that had been made about the dual control of the Coastal Command, the Admiralty and the Royal Air Force believed that the existing arrangements were the best that could be adopted in present circumstances, but whenever possible they intended to improve them. These criticisms had been linked with complaints about the coastal attacks by enemy aircraft. No air defence could be an impenetrable barrier. It was impossible to undertake to intercept every tip-and-run raid over a coastal line of 700 miles. He could give an unqualified assurance that plans were ready in the event of it being decided that the bomber force should be engaged on major operations. A number of new and powerful types of long-range fighters were now in production.

The Airways Corporation

THE state to which the amalgamation of Imperial Airways and British Airways has progressed is uncertain in the minds of many people, and it is hoped that the following notes may clarify the position.

The two companies so far as aircraft and maintenance equipment are concerned, are operating as one, and the Bill which will convert them into the British Overseas Airways Corporation has been duly enacted, and became law upon receiving the Royal assent on August 4, 1939. It now remains for the Secretary of State for Air to appoint the day upon which the Corporation shall take over the businesses of the two companies and pay the agreed purchase prices in cash to them. It is still impossible to say when the "appointed day" will be, and at the request of the Government there is a further temporary postponement until April 4, 1940.

The sums involved in the transaction are: to British Airways, £573,500; and to Imperial Airways, £2,659,085. What is perhaps not generally realised is that the Act (British Overseas Airways Act, 1939) provides that "The Vendor Company shall be entitled to have allotted to it . . . such an amount of the Corporation's Stock . . . as at the price of issue would be purchasable with the" above-mentioned sums in each case. Each of the companies can convert into holdings The Airways Corporation

To the purchase price to be paid, interest will be added at the rate of 4 per cent. per annum, less tax, from April 1, 1938 in both cases. The amount to be paid to Imperial Airways shareholders is 32s. 9d. for each £1 share. On February 29 these shares stood at 34s. 1½d.

Transatlantic Air Mail

THE Scandinavian aviation delegation sent to New York a short while ago have cabled home a report of their proceedings with U.S. federal authorities. The report states that the C.A.C. have informed the delegation that no American enterprise will be allowed to run the proposed airmail service between New York and Scandinavia, but there are no objections to such a service being operated by the Scandinavian companies on condition that rates correspond to those applying to other transatlantic services operated from the United States.

Negotiations are stated to have progressed so far that a favourable result may be expected in the near future. The delegation recommends a suggestion that the joint Scandinavian companies should charter two American flying-boats to operate the service for a year or two, until the technique of operation has been developed to a stage that will permit the use of landplanes, in which case either six-engined Fokkers or four-engined Douglases would come into consideration.

Obviously with a view to looking for suitable equipment, the delegation reports a visit to the Douglas factories in Santa Monica, California, and the United Aircraft works at East Hartford. The delegation will be back in Copenhagen by the end of March.

Quoting the Swedish delegate, Mr. P. Norling, the *Göteborgs Handels och Sjöfartstidning*, Gothenburg, recently stated that the projected airmail service would be run between New York and Bergen, from which latter special feeder lines for transatlantic mail would radiate to Oslo, Stockholm, Tallinn and Copenhagen, and possibly also to Amsterdam and Brussels.

SERVICE AVIATION

AWAITING THEIR TURN: Vickers Wellington bombers just "off the line," with a machine of the same batch taking off for its routine test.

Royal Air Force and Official Announcements

National Registration

OFFICERS and airmen who leave the Service should, whether previously included in the National Register or not, make application in person to the National Registration Officer of the area in which they reside for the issue of identity cards. The address of this officer for any area or locality is usually the office of the local council, but this can be verified by enquiry at a local police station.

Radio Mechanics

MORE than 13,000 radio enthusiasts have applied for enrolment in the new R.A.F. trade of radio mechanic, announced by the Air Ministry three weeks ago. Besides enquiries made by applicants in person, the Air Ministry Information Bureau has dealt with 3,150 telephone calls and nearly 4,000 letters and postcards on the subject.

Aero Club de France—Honorary Membership

THE Aero Club de France has organised a centre at the club premises at Nos. 6 and 8, Rue Galilee, Paris, 16eme, where officers of the British and French Air Forces may meet and mutually enjoy the amenities of club life.

Membership cards are obtainable, provided officers support their applications with the recommendation of their C.O.s, and membership of the club will be free for the duration of the war.

Royal Air Force

General Duties Branch.

Acting Pilot Officers on probation graded as Pilot Officers on probation:—(Nov. 6, 1939) E. H. Alexander, P. A. Dudeney, A. E. Q. Bourgeois, A. E. Hill; (Feb. 1) P. D. Bowen, F. A. Bowler, A. W. Clarke, F. G. H. Dench, J. S. Paish, M. C. G. Sherwood, J. J. Walsh, J. B. Ashton, I. P. C. Goudge, W. P. H. Rafter, H. J. C. Tudge; (Feb. 4) J. E. G. Fennell, J. D. Mallinson, E. O. Walsh; (Feb. 9) R. P. Cross. Flying Officers promoted to rank of Flight Lieutenant:—(Jan. 15) D. V. W. Francis; (Feb. 26) M. W. B. Knight, A. D. Annand, C. E. Drapper, P. H. Rebbeck.

THE DRYING ROOM of the parachute section of an R.A.F. bomber station. These 'chutes belong to a squadron which has been continuously engaged on long-distance flights, many of them over Germany, since the outbreak of the war.

Service Aviation

Pilot Officers promoted to rank of Flying Officer:—(Feb. 23) R. K. F. Bell-Irving, A. A. M. Dawbarn, P. S. Q. Andersen, I. W. Hutcheson, R. A. Craigie, H. J. N. Lindsaye, D. Shawe, A. L. McDowell, H. G. Evitt, A. C. Peach, J. A. H. Cooper; (Feb. 24) A. C. Glenday, J. R. Neill, R. W. McCarthy, D. Carlson; (Feb. 27) L. R. G. Mitchell, A. D. Mitchell; (Feb. 29) J. Ing, R. B. G. E. Clark, J. C. G. Sarll. Flying Officers relinquish acting rank of Flight Lieutenant:—(Nov. 3, 1939) M. W. B. Knight; (Nov. 26, 1939) G. V. Smither; (Jan. 1) R. H. Dingle. Following relinquish short service communications (ill-health):—Feb. 28) F/O. R. Clarke; (Mar. 2) Acting Pilot Officer on probation V. A. Mumford, F/O. (Hon. Flt. Lt.) A. R. W. Shipley (Duke of Cornwall's L.I.) relinquishes temporary command on return to Army duty, Jan. 8. Short service commissions of following Acting Pilot Officers on probation terminated on cessation of duty on dates stated:—(Feb. 7) J. H. Walker; (Mar 1) J. A. MacGregor.

Equipment Branch.

Pilot Officers promoted to rank of Flying Officer:—(Nov. 28, 1939) R. L. Browning; (Feb. 28) G. G. Cartridge.

Medical Branch.

Commission of Flying Officer R. J. A. Morris is ante-dated to Feb 1, 1939, and he ceases to be seconded to Royal Infirmary, Dundee, with effect from Feb. 1.

Princess Mary's R.A.F. Nursing Service.

Staff Nurses confirmed in appointments:—(Dec. 1, 1939) Miss S. M. G. Rathbone; (Dec. 5, 1939) Miss E. M. Browne; (Dec. 12, 1939) Misses I. Jones, A. M. Swain, (Dec. 15, 1939) Miss B. M. Macdougall; (Dec. 28, 1939) Miss O. M. Osmond; (Jan. 3) Miss M. F. Giles; (Jan. 4) Miss E. Hardy.

Royal Air Force Reserve

RESERVE OF AIR FORCE OFFICERS.

General Duties Branch.

Flight Lieutenant E. G. Holden granted rank of Squadron Leader, Dec. 1, 1939. Flight Lieutenant H. M. St. J. Carpendale relinquishes commission on cessation of duty, Jan. 2. Following relinquish commissions (ill-health), Mar. 2, 1940:—Flt. Lt. L. G. Gray, P/O. J. F. Grady. Following relinquish commissions in class CC:—Air Commanders (Aug. 24, 1939) R. F. S. Morton; (Sept. 3, 1939) H. R. Busteed; Group Captain: (Nov. 2, 1939) A. D. Cunningham; Wing Commander: (Sept. 1, 1939) H. Dawes; Squadron Leaders: (Aug. 23, 1939) F. J. Taylor, (Sept. 1, 1939) F. E. Bishop, G. R. Hicks; Flight Lieutenants: (Aug. 22, 1939) F. R. Jones; (Aug. 28, 1939) A. H. Goldie, E. R. Hockaday; (Sept. 1, 1939) D. S. Earp, C. J. Elliott, E. E. Ellison, C. H. Glover, W. W. Hart, E. M. Morris, R. J. Read, C. K. Turner, H. E. Sales, E. F. Wain, H. J. A. Williams; (Sept. 2, 1939) P. J. Bett, F. T. K. Bullmore, M. V. de Satgé; (Sept. 3, 1939) S. H. Bell, G. E. E. Singleton, R. J. Twamley; (Sept. 20, 1939) R. E. Hall; (Sept. 23, 1939) R. L. Bateman; (Sept. 24, 1939) A. M. Butt; (Nov. 20, 1939) F. R. Balfour; (Dec. 11, 1939) J. C. Brice.

Flying Officers:—(Aug. 26, 1939) T. J. Shaw, E. G. Whinney; (Sept. 1, 1939) R. L. Bennet, A. L. Brain, H. J. Forster, K. W. Pell, C. J. Pooley, L. G. Rumsey, A. H. Grace, T. R. Wheatley; (Sept. 2, 1939) C. H. Williams; (Sept. 3, 1939) G. G. Dixon, E. N. Fenton, W. R. A. Matheson, I. N. Roome; (Sept. 23, 1939) R. C. Warner. Notification in *Gazette* of Nov. 28, 1939, concerning Flt. Lt F. J. Sherman cancelled.

Equipment Branch.

Following relinquish commissions in class CC:—Squadron Leaders: (Sept. 1, 1939) A. Jukes, L. A. Lavender; Flight Lieutenants: (Sept. 1, 1939) E. S. Bullen, H. Cartwright, W. B. Frederick, G. J. Maygothling, L. N. Sargent, R. W. Stewart, H. F. Webb; (Oct. 25, 1939) J. C. Shakeshaft.

Royal Air Force Volunteer Reserve

General Duties Branch.

Granted commissions for duration of hostilities as Acting Pilot Officers on probation:—(Feb. 10) J. O. Bostock, R. E. C. Butterworth, V. Kelly, F. J. Kelsh, C. H. Kippen, L. P. Light, J. V. Midwinter, J. W. Renwick, N. H. Sagar, F. A. Wray.

The following are granted commissions for the duration of hostilities in the ranks and on the dates stated. Pilot Officers on probation:—(Jan. 14) S. N. Pearce. Leading Aircraftmen:—E. Anderton, E. C. Cox, J. R. Drewry, F. E. Frayn, M. J. Sainty, T. M. Taylor, D. J. D'Alton, C. H. B. Hall, H. B. Hunter, G. B. Read, P. S. Sidney-Smith, S. G. H. Spain, J. L. Spiller, J. R. Swift, G. D. Waterer, J. Whitton. Acting Pilot Officer on probation:—(Jan. 21) J. L. Harms. (Substituted for notification concerning these officers in *Gazette* of Feb. 6.)

Administrative and Special Duties Branch.

Flying Officer T. L. Grey (R.A.F., Ret.) granted commission as Flight Lieutenant Sept. 1, 1939. Granted commissions for duration of hostilities as Pilot Officers on probation:—(Nov. 5, 1939) M. F. Comer; (Nov. 13, 1939) C. J. Miln; (Jan. 17) J. E. Dunning; (Jan. 18) A. W. H. Longstaff; (Jan. 31) P. C. I. Elderton, C. W. Wright; (Feb. 1) R. J. Mackay; (Feb. 3) F. T. Harris, J. E. Lonsdale, J. P. Lynas, H. W. R. Trigg; (Feb. 4) R. W. G. Scott; (Feb. 5) R. E. Cox, E. J. Robinson; (Feb. 7) J. MacG. Asher, R. D. H. Osborne, H. A. Shewan; (Feb. 8) R. E. E. Barton; (Feb. 9) J. H. Flynn, N. N. McKinnon; (Feb. 10) A. Baker, M. H. C. Slaytor; (Feb. 11) D. H. Simmons; (Feb. 12) C. M. Afzal, K. R. Riddell, A. W. Sharpe, A. G. Wingate-Gray; (Feb. 13) J. Addison, T. A. Lloyd, A. J. McCarthy, D. S. Meglaughlin; (Feb. 14) W. Berwick, D. H. Jones, E. Lister; (Feb. 15) J. O. Barclay, A. E. Charlwood, L. Cook; (Feb. 16) H. L. Bird, A. A. Booth, T. T. Brown, V. J. Chipperfield, D. C. Cooney, M. C. Couzens, J. W. Davies, G. M. Fossick, C. A. H. Goudie, V. C. D. Gray, F. A. Holmes, D. M. Jack, D. C. Thompson, G. F. Turner; (Feb. 19) C. R. Guy; (Feb. 27) S. H. Bonsor.

A. L. Macmillan granted honorary commission as Squadron Leader, Feb. 26. Pilot Officers on probation confirmed in appointments and promoted to Flying Officer:—(Sept. 1, 1939) W. H. Williams; (Sept. 6, 1939) H. O. Edmonds; (Sept. 8, 1939) A. B. Austin, S. Bishop, L. V. Dodds, F. C. Gillman, A. H. Narracott, J. W. Piggott, M. Wideman, T. S. Sprigg; (Sept. 13, 1939) W. A. J. Lawrence; (Sept. 28, 1939) E. C. Hucklebridge, F/O. L. E. Barry promoted to Flight Lieutenant, Sept. 1, 1939; F/O. R. C. Vaughan transferred to Equipment Branch, Feb. 24. Notification in *Gazette* of Nov. 28, 1939, concerning Capt. F. J. Sherman (Sp. U.L. 1A) cancelled.

Equipment Branch.

G. E. Dimmer granted commission for duration of hostilities as Pilot Officer on probation, Sept. 3, 1939 (subject for notification in *Gazette* of Oct. 10, 1939). F. L. Edgerton granted commission for duration of hostilities as Acting Pilot Officer on probation, Jan. 15. Pilot Officers promoted to Flying Officers:—(Jan. 12) R. H. Gollan; (Feb. 16) D. F. Tubbs; (Feb. 23) C. J. Newton, G. H. Grasty, F. W. Hamblin, N. C. Kirkham; (Feb. 29) F. J. Smith.

Accountant Branch.

H. J. Howes granted commission for duration of hostilities as Pilot Officer on probation, Oct. 9, 1939 (subject for notification in *Gazette* of Nov. 28, 1939).

Medical Branch.

Granted commissions for duration of hostilities in ranks stated:—Flight Lieutenants: (Feb. 6) L. O'Connor; (Feb. 13) S. K. Sledge; Flying Officers: (Feb. 6) J. W. Cope, D. C. Moore, J. H. O'Connell, S. Perry, T. B. Purdy, A. G. Turner, H. D. Welch; (Feb. 13) A. J. Beddie, F. J. C. Matthews, R. G. Record, E. L. Rees, S. C. Williams.

Chaplains Branch.

Granted commissions for duration of hostilities with relative rank of Squadron Leader:—(Feb. 14) Rev. C. A. Parkinson; (Feb. 15) Rev. T. Duncan; (Feb. 15) Rev. A. B. Purdie; (Feb. 19) Rev. F. N. Towndrow; (Feb. 20) Rev. W. H. L. Wright.

Errata.—In *Gazette* of Oct. 20, 1939, notification concerning Lt. H. V. Alexander (I.A., Ret.). For Administrative and Special Duties Branch read Equipment Branch. For F. S. Symonson read F. S. Symondson.

Auxiliary Air Force

General Duties Branch.

606 (NORTH RIDING SQUADRON).—Flt. Lt. K. Pyman relinquishes commission (medical unfitness), Mar. 2.

615 (SOUTH YORKSHIRE) SQUADRON.—Acting Pilot Officer on probation K. Holden confirmed in appointment and graded as Pilot Officer, Sept. 4, 1939.

924 (EAST LANCASHIRE) SQUADRON.—Acting Pilot Officer on probation H. Hollins relinquishes commission (medical unfitness), Mar. 2.

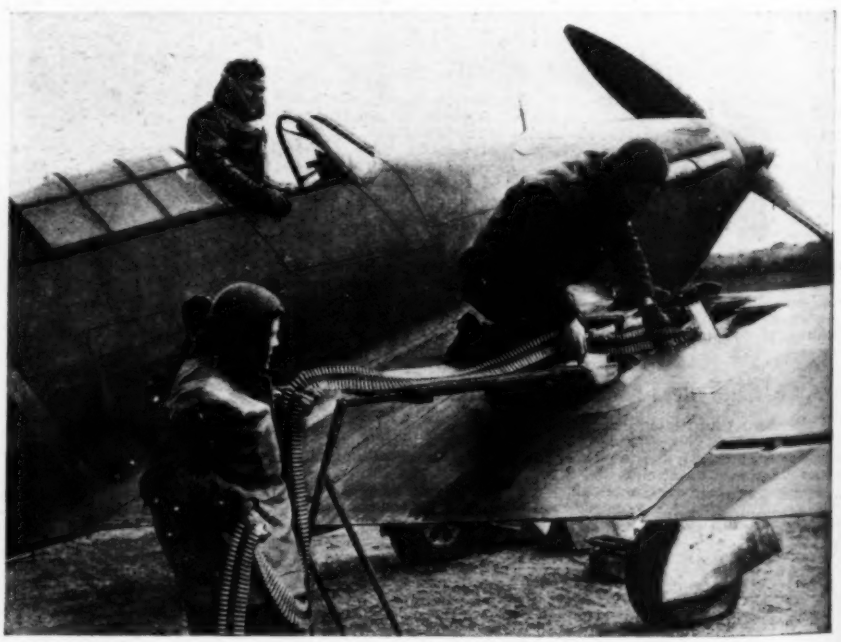
Equipment Branch.

Capt. W. A. M. Hanson relinquishes commission, Feb. 13. Flt. Lt. T. L. Grey relinquishes commision on appointment to commission in R.A.F. Vol. Res., Sept 1, 1939.

Erratum.—In *Gazette* of Jan. 2 notification concerning Flt. Lt. N. A. Copley-Smith: For Aug. 29, 1939, read Sept. 2, 1939.

Women's Auxiliary Air Force

Appointed Assistant Section Officers on Feb. 24:—Aircraftwoman 1st class Miss P. Allen, Cpl. Miss P. Beecroft, Aircraftwoman 2nd class Miss P. E. Chiswell, Cpl. Miss M. A. Everard, Sgt. Mrs. E. M. Fairbrother, Cpl. Mrs. P. K. Foxall, Sgt. Miss P. J. Gordon-Smith, Aircraftwoman 2nd class Miss E. M. Goulé, Cpl. Miss B. M. Green, Aircraftwoman 1st class Mrs. H. E. Mackey, Cpl. Miss W. E. Morley, Aircraftwoman 2nd class Miss P. M. Oliphant, Cpl. Miss M. E. Paton, Aircraftwoman 2nd class Mrs. A. R. Richardson, Aircraftwoman 2nd class Miss L. G. Taudevin, Assistant Section Officer Mrs. M. B. Curtis relinquishes appointment, Nov. 27, 1939. Assistant Section Officer Miss M. H. Browning relinquishes appointment (ill-health), Sept. 4, 1939



ONE OF EIGHT: If the number of rounds which can be counted in the belt is multiplied by eight and allowance is made for a section which is out of the picture, some idea of the amount of ammunition carried by our eight-gun fighters may be formed.

DYNAMIC SIMILARITY

Saunders-Roe Produce a "Flying Scale Model"

"Flight" photograph.

The somewhat unusual shape of the steps is clearly visible in this view of the SARO Flying Scale Model.

AIRCRAFT production has become an expensive business. Time was when a new aeroplane could be (in the early days of flying it had to be) produced for a few hundred pounds. But size has increased, materials have become expensive, equipment has multiplied a hundredfold, and modifications have become almost impossible once a type has gone into production. One result of all this is that designing "by eye" or "by guess" no longer meets the case. Not only so, but the most elaborate calculations, the most careful tests of scale models in wind tunnels, and even tests at high Reynolds Number in compressed-air tunnels and with airscrews running are apt to leave unknown, or at least doubtful, features which may assume important dimensions in the finished machine. Even the so-called "dynamic model," that is to say, the model in which not only the external shape but the c.g. position and the moments of inertia are truly represented, cannot be relied upon to provide all the information sought in the early stages of a new design.

This, of course, is particularly so in the case of a design which departs considerably from any previous ones of which the firm in question has had experience. During recent years there has been a tendency among aircraft manufacturers to go to the trouble and expense of building actual scaled-down models of any important new type proposed. In this way all features which might be doubtful can be thoroughly examined and tested, and modifications are nothing like so expensive to make as would be the case if the full-size machine had gone into production.

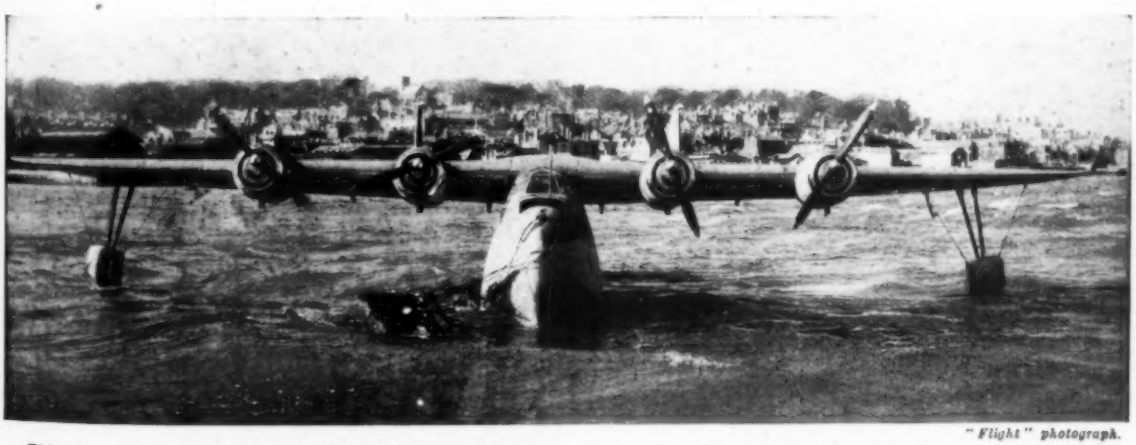
"Flight" photograph.

Flt. Lt. Ash, who has carried out the test flying of the SARO Flying Scale Model.

To be truly comparable with the large aircraft which it represents, the flying model must be in every way a replica of the full-size machine. In the airframe itself this does not present very great difficulties. It is different with the engines, however. Strictly speaking, these should be exact scale models of the "real" engines which it is proposed to use, and the airscrews should be to scale also. That is an ideal which obviously cannot always be attained. It so happens, however, that the Pobjoy engine of some 90 b.h.p. comes very close to being a scale model of modern large radials. What helps is that, in spite of its relatively low power, the Pobjoy engine has reduction gearing for its airscrew.

The latest firm to build a flying scale model is Saunders-Roe, Ltd., of Cowes. The new machine was demonstrated last week by Flt. Lt. Ash, and created a very favourable impression, not only being fast and very manœuvrable in the air, but showing good sea qualities, clean running and absence of porpoising.

That the actual Saro flying model is not a very tiny machine is shown by the fact that the overall length is 42ft. 8¾in. and the wing span 50ft. If it is assumed that the large flying boat of which this is a model is to be two and a half times as large, we arrive at a four-engined flying boat of 125ft. wing span. There is, of course, no reason why the full-sized machine should not be much larger than that. The similarity, except possibly for percentage structure weight, holds good.



"Flight" photograph.

This view of the SARO Flying Scale Model at moorings gives a good idea of the relatively narrow beam and the tumble-home sides. In the full-scale machine the outboard floats will be retractable.

PURER AQUA PURA

Water for the R.A.F. in the Field

WHEREVER an army or an air force, or, for that matter, any collection of human beings and animals exist, clean water becomes an absolute necessity. As Kipling put it:—

. . . when it comes to slaughter,
You will do your work on water,
An' you'll lick the blooming boots of 'im that's got it.

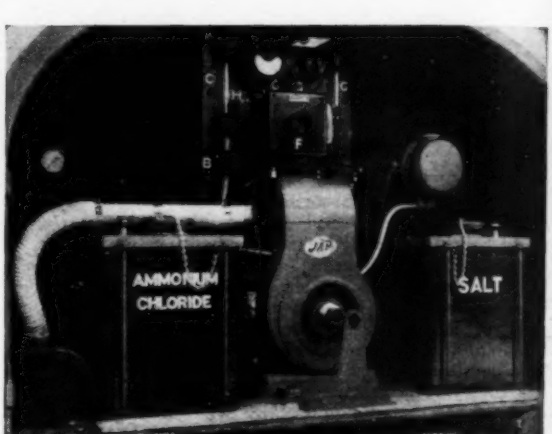
The services in this war are going to be a good deal better off than were their predecessors in previous campaigns, when the ravages of sickness—more often than not due to bad water—were responsible for more casualties than those caused by enemy action. If there is fresh water (as distinct from salt water) of any sort available, whether it be from a field ditch, or a muddy water hole, or even a well down which bodies have been thrown to poison it, there will be water which is both purified and sterile available for the troops.

Modern Chlorination

E.C.D., Ltd., Tonbridge, Kent, water purification engineers, of whom the moving spirit is Dr. D. J. Evans, have been hard at work on this problem for some eight or nine years, and are now producing in large numbers for all three fighting services water purifiers which are both self-contained and transportable.

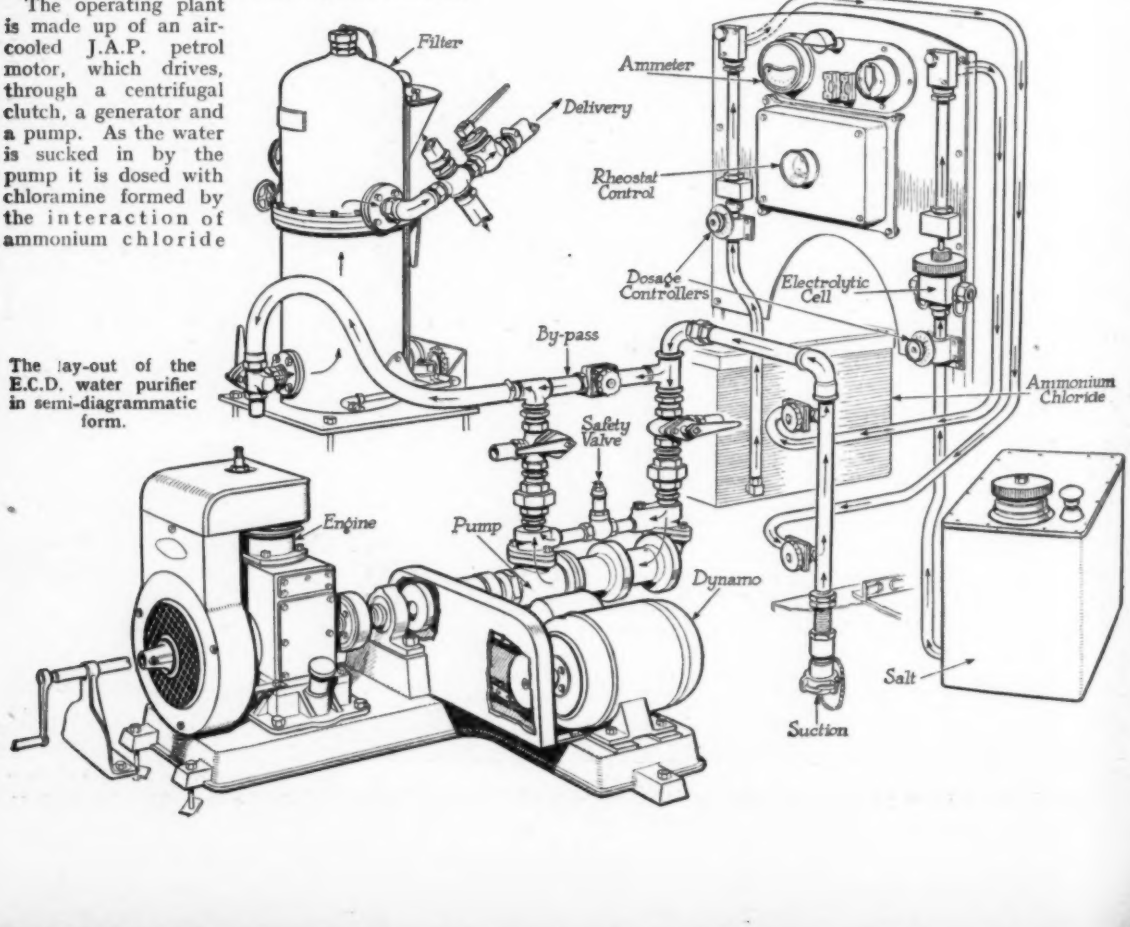
The purifiers for the R.A.F. take the form of trailers carrying a 300-gallon tank, a number of small 8-gallon containers for issue to small sections of men, and the necessary engine and apparatus for purification. The output is 500 gallons per hour, and the chemical containers are based on a four-hour or 2,000-gallon schedule.

The operating plant is made up of an air-cooled J.A.P. petrol motor, which drives, through a centrifugal clutch, a generator and a pump. As the water is sucked in by the pump it is dosed with chloramine formed by the interaction of ammonium chloride and sodium hypochlorite, these being passed in measured quantities by dosing chambers on the control panel.



The power unit, control panel and chemical containers of the E.C.D. purification plant.

The sodium hypochlorite is made by the electrolysis of common salt solution by passing this latter through an electrolytic cell interposed between the salt solution storage and the intake side of the main pump. The purpose of the ammonium chloride is to maintain for a longer period



The lay-out of the E.C.D. water purifier in semi-diagrammatic form.

A row of R.A.F. water purification trailers on final test.

the sterilising activity of the sodium hypochlorite; it also plays a part in the deodorising and taste prevention.

The water which is now chloraminated next passes through a filter for clarification. This filter is of special and robust design, and utilises a filter bed of kieselguhr, or inert earth. The water passes first through the filter bed and then through the metal filter. Since it has already been chloraminated, it leaves this stage both clarified and sterilised.

Care has been taken to make the operation of the unit as simple and foolproof as possible. The ammonium chloride is supplied in 5-grain tablets, 24 of which are used to make up the ten gallons of solution required for the four-hour schedule, and the salt is carried in 10 lb. bags to obviate any measuring. The ammeter is the tell-tale of the whole outfit. According to the amperage shown as passing through the electrolytic cell, so a known dosage of chloramine is being given. Four amperes, for instance, ensures a dosage of one part per million, while a reading of 12 amperes would mean that four parts per million were being injected in a flow of 500 galons per hour. Since the dynamo is on the pump side of the centrifugal clutch, it is impossible for false readings—owing, for instance, to clutch slip—to appear on the ammeter, or for the gallonage and dosage to get out of step. If the filter becomes choked and pressure builds up, the revs. will drop, and again this will show on the ammeter dial.

In these days of scientific warfare, pure water in the field is an absolute necessity, but the feature which will appeal to the troops most—especially to old soldiers who can remember chlorination as it used to be—is the fact that the water from this process is both tasteless and odourless.

THE INDUSTRY

Brush Sales Extension

DUE to the expansion of their sales organisation in the north-west area Brush Electrical Engineering Co., Ltd., Loughborough, have found it necessary to provide new offices for this purpose.

The new offices are at Daimler House, Wilmslow Road, Rusholme, Manchester, 14, and the telephone number Rusholme 2205/7. The offices at Haworth Buildings, Cross Street, have been vacated.

May and Baker Fire

THE fire which broke out at the warehouse of May and Baker, Ltd., of 42/43, St. Paul's Churchyard, London, E.C.4, on Wednesday, February 21, caused very severe damage and almost completely gutted the lower floors.

We learn that May and Baker, Ltd., have very large stocks in sub-depots conveniently situated in and around London and it is not expected that there will be any delay in meeting the requirements of their many customers in the aircraft and allied industries. For the time being, however, they are unable to deal promptly with small orders for the fancy goods trade, which entail unpacking and repacking. In view of the circumstances, May and Baker, Ltd., ask their customers to make some allowance for any slight delay that might be experienced in executing orders. Good supplies of Rhodoid are arriving regularly from their works, and it is hoped that the inconvenience caused by the fire will be overcome in a week or two.

Incidentally, the way in which the stock of Rhodoid stood up to the fire was little short of amazing, as although the interior was for over an hour a blazing furnace, damage to the thinner material is largely due to water, while the greater part of thicker material has remained in perfectly satisfactory condition.

The wooden racks holding much of the stock were destroyed, but the Rhodoid stocked on the shelves is but slightly fused at the edges, and stands a convincing witness to its own non-inflammability.

Leytonstone Production

THE Leytonstone Jig and Tool Co., Ltd., of 606, High Road, Leyton, London, E.10, are now making every effort to increase production in order to make the best possible contribution to the war effort.

This Company specialises in the design and manufacture of press tools, jigs, fixtures and assembly tools for aero engines. For many years now large quantities of these tools have been produced for most of the aircraft and engine manufacturers. Double shifts are now being worked and important extensions to the existing two factories have already been commenced. The drawing office is also very busy at the moment designing press-tools and jigs, for air-frames.

The whole of their plant is being modernised, and important additions are on order. These include a battery of Cincinatti Milling machines, a Churchill hydraulic surface grinder, a further Genevoise jig-borer, a batttery of Herbert and Timbrell and Wright Capstan lathes, and Lang Holbrook and Lee Blonde tool-room centre-lathes.

In view of the large quantity of turned and screwed components now required for quantities of tools, premises have been taken for a production turning shop. It is hoped that this will greatly increase production of these urgently needed parts.

The Leytonstone Jig and Tool Co. also manufacture as sidelines ratchet spanners and shims, and considerable orders for these are in hand.

It is hoped that by the end of the year this Company will have doubled last year's production figures.

Rotherham Relief Valve

IT has been established that the normal type of relief valve unit, whether formed integral with the fuel pump or installed as a separate unit in the pipe line, gives rise to many of the fuel system difficulties encountered. Investigation has proved that in the setting of a valve to release pressure at the usual rate of 2½ lb. per square inch, the lifting capacity of the pump is seriously restricted; furthermore, any variation of suction head (brought about by varying attitudes of the airframe in flight) may affect pressure delivery to a dangerous degree.

This state of affairs has necessitated the recent practice of installing pressure-reducing valves at the pressure side of the pump, but unfortunately this does not constitute a 100 per cent. cure. Many other variables such as minimum and maximum air intake pressures dis-

Industry (continued)

turb the desired fuel delivery pressures.

The maximum depression likely to be encountered in the suction pipe in any given installation is dependent mainly upon the maximum suction head, diameter, length and contour of the pipe line and restrictions in the pipe line. That depression, in acting upon the effective area of the relief valve, tends to pull the valve off its seat, thereby resulting in erratic delivery.

It is possible, of course, to spring-load the valve sufficiently to withstand this pull and at the same time maintain a constant delivery pressure so long as the aircraft is stationary, but as soon as the craft is air-borne the different effective suction heads encountered in flight upset delivery pressures.

A Balanced Valve

A practical solution is to balance the relief valve, and the Rotherham valve has been designed with this in view. By interconnecting the valve with a diaphragm of an equal effective area, the variable loadings encountered under flight conditions automatically balance out and leave the valve unbiased except for the constant spring load to give the desired delivery pressure. In certain types of high-speed aircraft relatively high air intake pressures may be encountered. In these instances it may be necessary to balance out by leading a pipe line from the air intake to the under side of the diaphragm, thereby maintaining a constant effective delivery pressure to the float chamber of the carburettor. It is to be noted that the Rotherham unit incorporates a valve somewhat larger in diameter than that normally employed, the object being to reduce the valve lift to the minimum.

The majority of fuel pumps in use to-day incorporate valves of the unbalanced type, and where pumps of this type are already fitted the Rotherham valve may readily be installed as a separate unit in the pipe line.

The overflow pipe should preferably be led to a point immediately behind the suction side of the pump, and it is not necessary to run the pipe back to the fuel tank.

It is to be noted that the latest practice is to incorporate in the fuel pump itself a balanced type of relief valve, a case in point being the American Pesco pump now fitted to the current types of Bristol engines.

The Rotherham relief valve unit has been designed for use in those earlier installations not equipped with pumps of the Pesco type.

An important feature not to be lost sight of is that a pump having a balanced valve is capable of dealing with its maximum suction capacity, whereas pumps having the unbalanced type of valve are able to cope with maximum suctions only when delivering at pressures of 15 to 20 lb. per sq. in. Clearly pressures of this magnitude are not suited to carburettors at present designed to cater only for pressures up to 3 lb. per sq. in. or so.

Factory Lighting

WARTIME illumination of factories is a difficult problem for any firm to solve. In most factories where artificial light is in use by day as well as by night the employees are inclined to grumble a little about the feeling of heaviness which is apparent under these conditions. The result is a degree of slackening in production.

"Modern Factory Lighting," a book which has recently been issued jointly by the British Electrical Development Association and the E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, London, W.C.2, deals extensively with all the problems of factory lighting and has a special chapter on wartime requirements.

Factory lighting legislation is covered, also the functions of industrial lighting, the choice of light sources, the design of lighting installations, and it also discusses a number of specialised industrial lighting problems.

Photographs, diagrams and charts have been used profusely to emphasise and simplify the text. The price is 8s. 6d.

AERONAUTICAL PATENT SPECIFICATIONS

(*Published March* 14, 1940.)

1938.

2110. BRISTOL AEROPLANE CO., LTD., FRISE, L. G., and PONTING, R. Gun-firing systems (518,113).

12138. WESTLAND AIRCRAFT, LTD., and PETTER, W. E. W. Aircraft aerofoils (518,065).

13811. BENDIX AVIATION CORPORATION. Carburettors for internal-combustion engines (517,964).

15657. WHITEHEAD, G. E. Wind-operated devices for use in elevated positions for obstructing or destroying hostile aircraft, and for other purposes (519,068).

21440. AIRCRAFT COMPONENTS, LTD., and BOUND, R. H. Locking and operating means of retractable parts of aircraft (518,073).

23,118. AEROPLANI CAPRONI SOC. ANON. Devices for the neutralisation of the aerodynamic thrust acting on the surfaces of guns mounted on aircraft (517,920).

23274. STONE & CO., LTD., J., and HATCHER, E. C. Retractable undercarriages for aircraft (518,922).

23974. LAURENCE, H. Doors for motor cars, aircraft, or other vehicles or structures (518,085).

24044. FINLAYSON, D., GREENWOOD, E. L., and WYLDE, J. R. Parachutes (518,101).

24070. CAREY, F. H. Collapsible struts for retractable undercarriages for aeroplanes and other purposes (518,130).

30822. GAYRAL, P. Aeroplanes (518,154).

(*Published March* 21, 1940.)

1938.

34754. COLLINS, F. E. Transportable splinter-proof armoured cells for anti-aircraft observers and others (518,165).

20669. BENDIX AVIATION CORPORATION. Temperature-compensated pressure-responsive indicating instruments and devices (518,264).

24178. AEROPLASTICS, LTD., and STILL, S. C. HART. Aircraft wing construction (518,178).

24181. GOODRICH CO., B. F. Apparatus for preventing ice accumulation on surfaces, for example, surfaces of travelling aircraft (518,180).

26316. HAASE, M. Device for protecting constructions from bombardments from the air (518,338).

1939.

9618. BURLS, M. R. Retractable undercarriages for aircraft (518,359).

20489. F. E. PROPRIETARY CO., LTD., and FINZI, G. Fire-extinguishing bombs or grenades (518,259).

PUBLICATIONS RECEIVED

The Blue Book, 1940; 25s., Benn Brothers, Ltd., Bouverie House, 154, Fleet Street, E.C.4.

Modern Ignition Simply Explained, by H. H. U. Cross; 5s., The Technical Press, Ltd., 5, Ave Maria Lane, Ludgate Hill, London, E.C.4.

L'Annee Aeronautique 1938-1939, by L. Hirschauer and Ch. Dollfus Dunod, Editeur, 92, rue Bonapart, Paris, France.

Modern Factory Lighting; Including special Wartime Requirements. British Electrical Development Association and the E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, London, W.C.2.

Simple Aerodynamics and the Airplane, by C. C. Carter; $4.50, The Ronald Press Co., 15, East 26th Street, New York, N.Y., U.S.A.

Annual Report of the Smithsonian Institution, 1938; $1.50, Superintendent of Documents, Washington, D.C., U.S.A.

NEW COMPANIES

DIXON ROLT DEVELOPMENTS, LTD.—Private company. Registered February 24. Capital £3,500 in 3,500 shares of £1 each. Objects: To acquire any interest in inventions and patents relating to the manufacture of motor and all wheeled vehicles and chassis, aircraft and accessories, marine steam and internal combustion engines, locomotives, etc. The directors are: Fdk. W. Dixon, Ardverness, Wray Common Road, Reigate, Surrey, engineer; Anthony P. R. Rolt, Brookfield, Nantwich, Ches., racing motorist.

FAIRFIELD AVIATION, LTD., was registered as a private company on February 26, with a nominal capital of £10,000 in 10,000 shares of £1 each. The objects are to carry on the business of aeronautical, mechanical, electrical and general engineers, manufacturers of aircraft and flying machines, water planes, motor boats and balloons, and component parts thereof, etc. The subscribers (each with one share) are: R. C. Bartlett, solicitor; F. C. Bright, managing clerk; I. B. E. Ford, private secretary; and S. M. Claughton, accountant and cashier; all of 27, John Street, W.C.1. Permanent governing director and chairman: Reuben C. Bartlett, of "Kenilworth," 35, Thetford Road, New Malden, Surrey (governing director of Redwing Aircraft Co., Ltd.). Secretary: F. C. Bright. Solicitors: R. C. Bartlett and Co., 27, John Street, Bedford Row, W.C.1. The registered office is at 27, John Street, Bedford Row, W.C.1.

W. COOPER (GRIMSBY), LTD.—Private company. Registered March 1. Capital £5,000 in £1 shares (2,000 cumulative preference and 3,000 ordinary). Objects: To carry on business as heating and constructional engineers and specialists, ventilating, lighting, electrical, radio, automobile and aviation engineers, metal workers, etc. The subscribers (each with one share) are: W. Cooper, 94, Welsby Road, Grimsby, engineer; W. B. Cooper, 66, Park Avenue, Grimsby, engineer. W. Cooper is permanent managing director. Qualification 100 shares.

BROCKLIN, LTD.—Private company. Registered March 5. Capital £1,000 in 1,000 shares of £1 each. Objects: To carry on the business of ironfounders, mechanical engineers and manufacturers of and dealers in engines for all kinds of aircraft, motor cars and other vehicles, etc. The directors are: James C. Nicklin (chairman), The Close, Ashton-under-Hill, Evesham, Worcs.; John W. Nicklin, "Grafton House," Cooper's Lane, Smethwick, Staffs.; John T. Brockhouse, "Cliveden," Hartopp Road, Four Oaks, Warwickshire; John W. Nicklin, Jnr. (managing director), Lloyds Bank House, Bearwood Road, Smethwick. Qualification: £125 shares. Remuneration as fixed by the company. Secretary: D. B. Tinley. Solicitor: Wm. Haddkiss, 185, High Street, Smethwick. Registered office: 185, High Street, Smethwick.

ALLTOOLS (CANADA), LTD., was registered as a private company on February 28 with a nominal capital of £100 in 100 shares of £1 each. The objects are: To carry on the business of manufacturers of and dealers in aeroplanes, seaplanes and aircraft component parts of all kinds, machine tools and lathes, plant and machinery of all kinds, engineers, etc. The subscribers (each with one share) are: W. Davidson, 182, Galliard Road, Lower Edmonton, N.9, solicitor's clerk; and T. W. Westrop, 6a, Stoneleigh Park Road, Ewell, Surrey, solicitor's clerk. The first directors are to be appointed by the subscribers. Remuneration as fixed by the company. Solicitors: B. A. Woolf and Co., 31, Lombard Street, E.C.3. The registered office is at 31, Lombard Street, E.C.3.

ANDREW WEIR INSURANCE COMPANY, LTD., was registered as a private company on February 29, with a nominal capital of £250,000 in 250,000 shares of £1 each. The objects are: To transact every kind of insurance, assurance, guarantee and indemnity business; to undertake, accept and insure against or upon the contingency or risk (including all such war and reprisals risks, and risks of a similar nature as may from time to time be lawfully undertaken) of any injury, loss, damage or liability arising to, or in respect of any persons, property, assets, rights and interests whatsoever; to insure against marine and aerial navigation risks, etc. The subscribers (each with one share) are: Henry R. Carlson, 21, Bury Street, E.C.3, insurance manager; James M. Duxbury, 21, Bury Street, E.C.3, chartering clerk. The first directors are to be appointed by the subscribers. No qualification required. Solicitors: Stephenson, Harwood and Tatham, 16, Old Broad Street, E.C. The file number is 359,580.

COLLEDGE BROTHERS, LTD.—Private company. Registered March 2. Capital £5,000 in 5,000 shares of £1 each. Objects: To carry on the business of mechanical, constructional and general engineers, manufacturers of and dealers in machinery, rolling stock, tools, aeroplanes, etc. The permanent directors are: Oscar L. Spedding, Park Hill, Stalybridge, Ches., engineer (director of William Heap and Co., Ltd.); and Joseph Colledge, 131, Bishop Street, Moss Side, Manchester, tool maker. Qualification: £10 ordinary shares. Remuneration as fixed by the company. Solicitors: Thompson and Cooke, 138, Stamford Street, Stalybridge. Registered office: Eagle Ironworks, Stalybridge, Ches.